

Air & Space

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The Milky Way
(see page 17)

National Air and Space Museum

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Air & Space

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MUSEUM HOURS

Until Labor Day (September 7) the Museum will be open from 10 a.m. to 9 p.m.; starting September 7, Museum hours will be 10 a.m. to 5:30 p.m. The Museum is open to the public every day of the year except Christmas. Admission is free.

On July 1, NASM's fifth anniversary, the Museum will remain open until midnight for a public birthday party. (See page 15 for details.)

For brevity, the National Air and Space Museum is often referred to in these pages as NASM. The National Aeronautics and Space Administration is NASA.

Briefing

Heroes

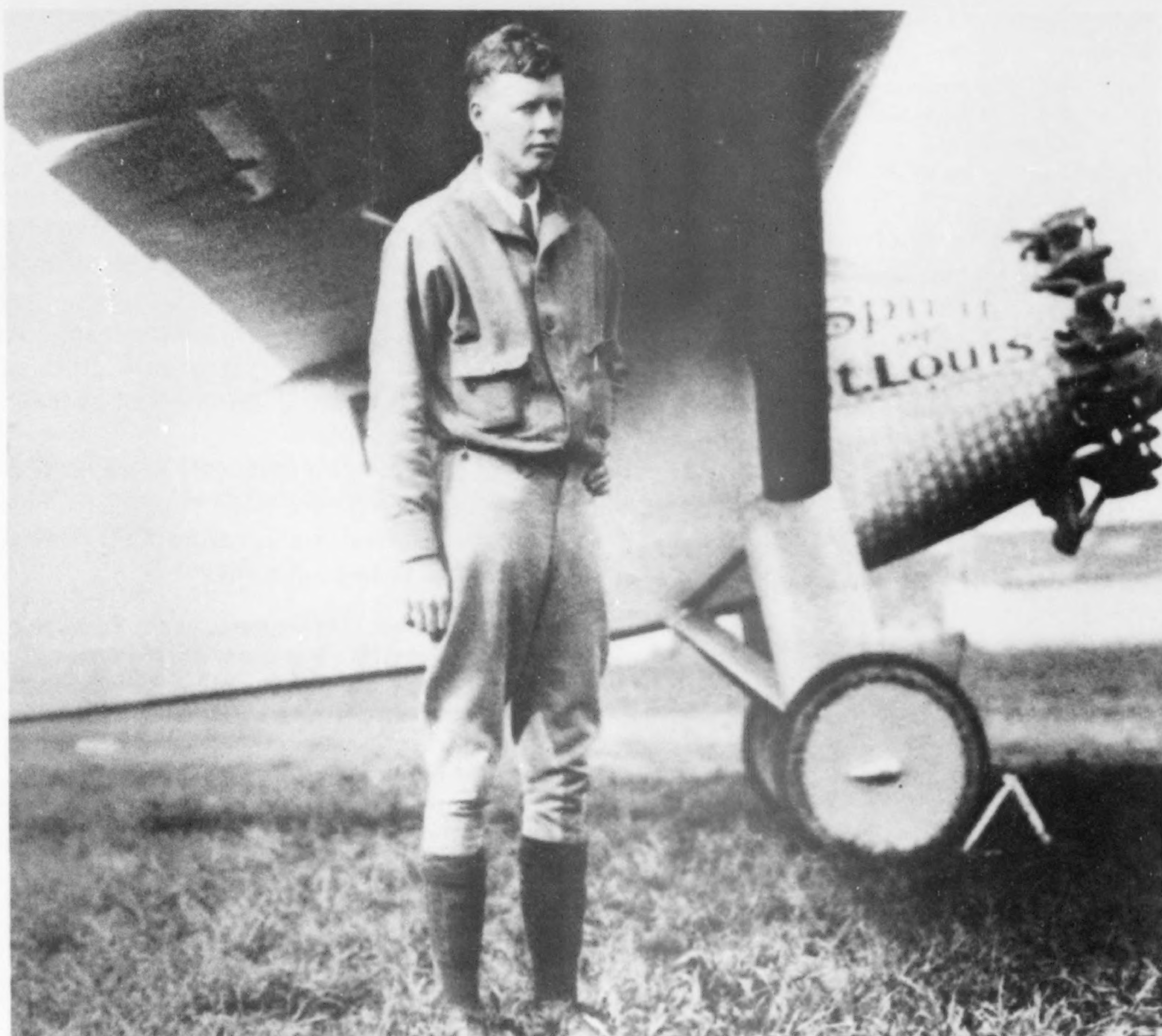
Noel W. Hinnners
Director, NASM

The National Air and Space Museum continues, almost five years after opening, to be the most popular museum in the world. One of the challenges to our staff is to understand just what it is that attracts the visitors and to give them more. Quite rapidly one concludes that it is a combination of things which are at work—a love of flying, personal nostalgic recollections of particular historical events, enthusiasm for and awe of space exploration, pride in the accomplishments of our country, the beauty of the airplanes, the vicarious experience of the movie *To Fly*, cleverly designed exhibits, and an impressive museum architecture. The focus of all these factors is the technological artifacts, frequently originals as is the case for the *Spirit of St. Louis* and the *Double Eagle II* or back-up flight model where the original, such as *Voyager*, is headed out of the solar system and beyond our ability to retrieve it!

But when a visitor looks at an artifact, the heart of what he sees is not the shiny metal or filmy balloon skin—rather it is an appreciation for the person or people who used the technology to accomplish a feat which had once been thought to be impossible or of overwhelming challenge. That the barriers, real or imagined, were overcome serves as a genuine inspiration, especially to youth. Indeed, many of the accomplishers are considered heroes, people admired for their achievements and noble qualities and considered models or ideals. Clearly such people as Charles Lindbergh, Jacqueline Cochran, John Glenn, Alan Shepard, and maybe the *Double Eagle II* crew (Maxy Anderson, Larry Newman, and Ben Abruzzo) fall in the hero category. Lots of other people don't, including many whose accomplishments were of equal or greater import. Why is that? What really makes a hero? Why is there no *Voyager* hero?

It seems to me that heroes have three distinctions in common: (1) they are individuals or small groups of individuals with whom one can identify personally, (2) their endeavor involved significant personal risk and endurance, (3) they succeeded where others failed, frequently in a competition.

No doubt the social context and public relations of the times contribute to whether or not a particular person is perceived as a hero. Usually conditions are not ripe for the public recognition associated with acknowledged heroes; thus, the world is full of "unsung heroes." Most of us revel at the prospect of the public acclaim that goes with a successful major accomplishment but most will never receive it, so it is senseless to set out with the goal of becoming a public hero; it is not senseless to aspire to become an unsung hero. Set for yourself goals which are achievable within your capability but which are demanding of endurance and intellect. Take delight in your personal accomplishments and be proud of them. To be your own hero, stopping short of overweening self-satisfaction, is to feel good about yourself and about life. The fall-out or spin-off is spectacular.



Charles Lindbergh and the Spirit of St. Louis in 1927.

Lindbergh

An American hero

Tom D. Crouch
Curator
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Millions of visitors make the pilgrimage to the Smithsonian Institution each year, drawn by a desire to see for themselves the priceless bits and pieces of their national heritage. They gaze at the Star Spangled Banner that Francis Scott Key saw still flying over the walls of Fort McHenry in the dawn's early light. They stroll past canvasses by Rembrandt, Picasso, Peale, and West; admire gowns worn by first ladies from Martha Washington to Nancy Reagan; and wonder at the fragility of the wooden boat that carried John Wesley Powell through the rapids of the Colorado River.

But for many of these visitors, the high point of the tour arrives when they walk through the doors of the National Air and Space Museum and see a small silver monoplane hanging overhead. In a museum filled with the most famous vehicles in the history of flight, from the world's first airplane to the Command Module that carried our first astronauts to the Moon, the *Spirit of St. Louis* retains its special significance.

For a people who have great difficulty distinguishing mere celebrity from genuine heroism, our continued interest in Charles A. Lindbergh and his achievement seems to require some explanation. This is particularly true when we realize that many of those visitors who instantly recognize the *Spirit of St. Louis* have only a hazy notion as to what Lind-

bergh accomplished. (He was the first to fly the Atlantic, wasn't he?) We are left with a question. Why do we remember, even revere, Charles Lindbergh long after other pilots and aircraft that made great flights have been forgotten?

Part of the answer lies in the enormous impact Lindbergh made on his own time. Few events in the history of aviation have so electrified the Nation and the world as did Lindbergh's solo transatlantic flight of 1927.

On the most obvious level, the flight was a demonstration of the maturity of aeronautical technology, forecasting the day when scheduled transatlantic air service would become a reality. However, it was the public perception of the Lindbergh personality that was to lend symbolic significance to the event. Jazz-Age Americans refused to view the flight as a simple triumph of technology over time and space. Rather, Lindbergh's achievement was seen as a reaffirmation of the importance of traditional values that seemed increasingly vulnerable in a more complex and mechanized world.

Charles Lindbergh could hardly have chosen a more auspicious moment to make his appearance on the American

scene. The Twenties had been a decade in search of a hero. Unlike other celebrities of the period, Lindbergh performed, not within the artificial restrictions of the playing field or on the movie lot, but on the limitless stage of the sky. Other pilots seeking to capture the \$25,000 Orteig Prize had adopted a team approach. Many had chosen to fly large multi-engine aircraft that seemed to offer some measure of safety and comfort. Charles Nungesser, Francois Coli, Noel Davis, Stanton Wooster, Richard Byrd, and Rene Fonck had all tried and failed. Stories of the death and injury of would-be transatlantic aviators had filled newspaper headlines for weeks.

Lindbergh appeared suddenly, setting cross-country speed records as he flew from San Diego to St. Louis, then on to New York. His airplane, a small single-engine monoplane, had been constructed by Ryan Airlines, a relatively unknown firm, in only 60 days.

Lindbergh dared to begin his journey while others waited for a break in the foul weather over the North Atlantic. The takeoff, a series of bounces off muddy Roosevelt Field, came on May 20, 1927, and seemed calculated to impress spectators with the dangers inherent in the enterprise. Then he was gone, flying alone while a world waited in suspense. From the moment the *Spirit of St. Louis* touched down at Le Bourget, the millions who searched for ideals and stabil-

Milestones of Flight, a sound-film-strip related to this article, is one of NASM's Flight series. For information about the series see page 18.

ity in an age of confusion and anxiety adopted Lindbergh as their own.

Writing in *Popular Aviation* in 1928, pilot Margery Brown focused on Lindbergh as the personification of traditional virtues in explaining the wave of enthusiasm and adulation that followed the flight:

Lindbergh is a symbol, more or less. It isn't Lindbergh the person who inspires them so much as it is Lindbergh as an ideal. They recognize in him qualities they would like to possess—courage, quiet confidence, modesty, and spiritual freedom.

The young aviator was cited as an example of the success that would come to those who attacked their problems

flight and achieve spiritual independence. Still more wonderful is the fact that this feat lies within the grasp of all of us. Students, the choice lies with you. Do not sigh for Lindbergh's wonderful luck, but determine to emulate Lindy's glorious pluck.

Clearly, the public perceived Lindbergh as a larger-than-life figure, a latter day folk hero. He was a modern frontiersman who pitted himself and his airplane against the forces of nature in much the same fashion as Daniel Boone had challenged the Kentucky wilderness a century and a half before. It seemed entirely appropriate to include Lindbergh's profile along with those of Boone, Washington, and Lincoln on the

forced a doubting public to take note of the possibility of travel beyond the atmosphere. During World War II, Lindbergh worked for the improvement of military aircraft and drew on his own vast experience and superb piloting skills to teach young aviators how to wring the last ounce of performance from their aircraft. During his tour of U.S. bases in the Pacific, he flew a number of unofficial combat missions himself, and is credited with the destruction of at least one enemy airplane.

But Lindbergh's interests were far too broad, his talents too enormous, to remain limited to aeronautics. As he himself was to comment:

When I look back on the early years, I realize it was the art of flying more than its science that intrigued me—it was the combination of an underdeveloped science with an art, resulting in adventure for the mind and body that brought stimulation to the spirit. As the science has developed, the art and adventure have declined—and with them, my interest.

During the 1930s he worked with Dr. Alexis Carrell of the Rockefeller Institute to develop a perfusion pump that would serve as a first step toward the creation of a heart-lung machine. His enormous prestige and knowledge of military affairs led to his rise as an influential, and not always popular, commentator on domestic and foreign affairs prior to 1941.

With the coming of peace he continued as a consultant to various military agencies, devoting long hours to the maintenance of U.S. aerospace leadership. During the post-war years, however, his attention was increasingly focused on problems of central concern to a world beset by environmental woes. He worked to save wilderness areas and to preserve vanishing animal species. He was particularly concerned with the plight of primitive tribes struggling for an accommodation with the modern world.

May 20-21, 1981, will mark the 54th anniversary of the first solo transatlantic flight. In observing the occasion, we will be commemorating far more than the flight of the *Spirit of St. Louis*; we will be honoring the career of Charles Augustus Lindbergh, the man who, more than any other, has come to symbolize the daring, skill, and judgment that have opened the heavens to mankind. ■

Readings

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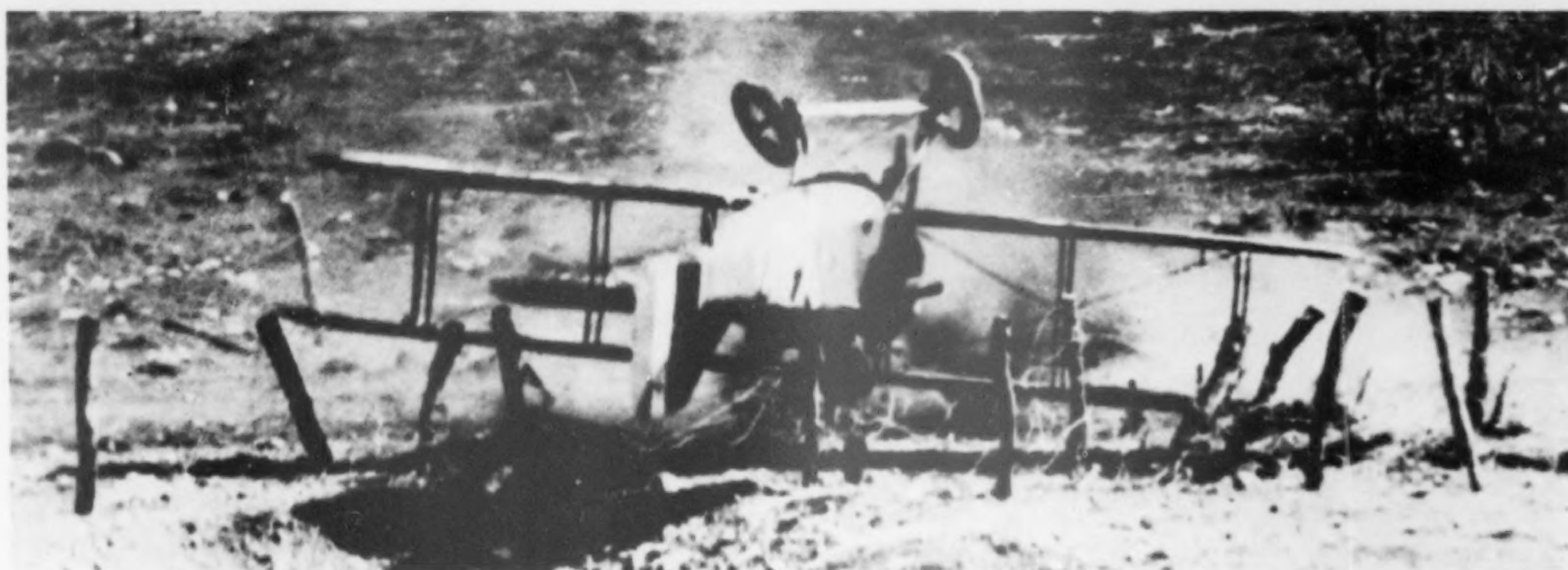
Lindbergh receiving congratulations in France shortly after the historic 1927 flight.

with courage, confidence, and perseverance. The 18-year-old editor of the San Marcos College student newspaper, Lyndon Baines Johnson, was one of many who saw Lindbergh as the ideal role model for young Americans:

Lucky Lindy is the hero of the hour, yet the adjective which most characteristically describes Lindbergh is not lucky, but plucky. . . . A sketch of his life reveals the grit and determination that have been outstanding traits of his. . . . He is a simple, straight-forward, plucky lad whose first lesson learned was self mastery. He did not give up when hardship and trials beset him. . . . His pluck carried him through to success and fame. . . . It is a wonderful thing to make the first trans-ocean

cover of the *Boy Scout Handbook* in use during the 1930s.

Catapulted to sudden fame, Lindbergh was to remain a public figure until his death in 1974. Through his activity as a consultant for a number of airlines and aircraft manufacturers, he left the indelible stamp of his personality on the growing aviation industry. The long distance flights that he undertook with his wife, Anne Morrow Lindbergh, pioneered routes that would one day be followed by passenger airlines. His interest and support of the early rocket experiments of Robert H. Goddard



Famous movie stunt pilot of the 20s and 30s, Dick Grace, "crashes" a SPAD in the 1928 silent film *Wings*, the winner of the first Academy Award. He survived all those movie crashes to fly in World War II.

Flying in the Movies

Hollywood's make-believe heroes

Donald S. Lopez
Chairman
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The scene: a German front line airfield in World War I. A Fokker D. VII takes off and climbs away from the field. A second Fokker starts down the field. As it lifts off the ground it is machine-gunned by the first plane and crashes into the ground. The pilot climbs from the cockpit, writhes in agony and collapses.

A real war scene? No. This was a scene from the 1928 silent film *Wings*, the winner of the first Academy Award. The first Fokker was actually a U.S. Army Corps P-1 painted to resemble the German fighter. However, the second Fokker was real, the crash was real, and the agony was real. Dick Grace, the stuntman and pilot, who regularly crashed airplanes for the movies, had made a slight miscalculation and had suffered a broken back in the crash. Surprisingly, despite this injury, and a warning from his doctor, he was back crashing planes again for the film *Lilac Time* in less than a year.

Deliberately crashing planes for the movies took more than just courage. A great deal of flying skill was required. In addition to being able to escape without serious injury, the crash had to be made at a precise time and location so that it would be caught by the cameras. The Fokker crash had to take place immediately after the firing pass made by the first Fokker (P-1). In an earlier crash for *Wings*, Dick Grace had crashed a SPAD, a World War I French fighter, so that it flipped over on its back, and, it took some courage for the cameramen to remain in place with cameras grinding as a plane crashed only 6.09 meters (20 feet) away.

While filming *Lilac Time* Dick Grace demonstrated his remarkable precision

by placing a handkerchief on the ground and then picking it up as he hung upside down in the cockpit after the crash. For this film, Grace was in complete charge of all the flying. He assembled a group of skilled pilots that called themselves "The Buzzard Squadron." This squadron accomplished all of the flying, including the crashes in the film.

In the major dogfight scenes eight additional pilots were used. Every morning for weeks the two formations of eight aircraft, one German and one British, would take off accompanied by three camera planes (two-seaters with cameramen in the rear seat) and engage in mock combat above the clouds. Despite having 19 aircraft in wild melees there were no midair collisions. Although no Buzzards were killed during the filming of *Lilac Time*, four died in flying accidents in the next two years.

Another flyer who performed many dangerous stunts in flying films was Lt. Ormer Locklear. (*The Man Who Walked on Wings* is the title of a book about him by Art Ronnie.) As an Army pilot in train-

ing, Locklear had become quite expert at wingwalking. On November 8, 1918, he became the first person to change from one plane to another in flight when he dropped from the landing gear of a Curtiss Jenny to the upper wing of another Jenny. He later developed the technique of climbing from the upper wing of one plane to the lower wing of another, which became the standard method of plane changing.

Even before his arrival in Hollywood several films had been made using wingwalking stunts originated by Locklear but performed by other daredevils. It was said that in 1919 there were more aviators than starlets in Hollywood. The end of World War I had released a large number of trained pilots who wished to remain in aviation, and many sought to capitalize on the glamour of flying to begin careers in the movies.

The two major films that featured Ormer Locklear were *The Great Air Robbery* and *The Skywayman*. Plots of both films were rather contrived and were designed to exploit his proclivity for flying gymnastics. Every airplane, whatever its mission, was equipped with a rope ladder that could be lowered surreptitiously to allow Locklear to change from a car, train, or plane to the plane carrying the girl, money, jewels, crooks, or some combination of the foregoing. In *The Great Air Robbery*, he dropped from the landing gear of a plane into a speeding car and, after the obligatory fistfight, caught the landing gear and climbed back onto the plane.

In his second and last film, *The Skywayman*, made in 1920, some new stunts were added. In one film Locklear changed, via a rope ladder, from a plane to the top of a speeding train, and again after the obligatory fistfight, back to the plane. In a second stunt, with the wing of his plane, he knocked the top off a steeple in which two thieves were hiding. The third stunt, a night spin illuminated by searchlights, was his last. The plane never recovered from the spin and Locklear and another pilot were killed. It is ironic that, after years of changing from,



Many of Hollywood's famous actors played pilots in the movies. Here pictured in *Command Decision*, a 1949 movie about World War II, from left: Clark Gable, Walter Pidgeon, Van Johnson, Brian Donlevy and John Hodiak.

and hanging all over the fuselage and wings of airplanes, he was killed while in the cockpit.

The advent of sound motion pictures in 1929 and the success of *Wings* encouraged many film studios to make films with aviation themes. World War I flying was a particularly popular subject and many films used it as the basic theme, including *Hell's Angels*, *Lilac Time*, *The Eagle and the Hawk*, *Sky Devils*, *Hell in the Heavens*, and *Dawn Patrol*.

Hell's Angels was by far the most ambitious. Produced and directed by Howard Hughes, just beginning his legendary career at 22, it took more than two years to film. The non-flying scenes were originally filmed silently but Hughes wisely decided to refilm them in sound.

A fleet of 97 planes, including 10 camera planes, were used in the film led by chief pilot Frank Clarke, a noted barnstormer and movie stunt pilot. Clarke, who also played the part of Lt. von Bruen, logged some 400 flying hours in a Fokker D. VII during the filming. Two airports were used, one for the Germans and one for the English. For two years, the air battles of World War I were refought above the State of California. Howard Hughes directed many of the battles from the cockpit of his private Waco biplane.

One of the climatic scenes in *Hell's Angels*, a dog fight involving 50 planes, is probably the most spectacular ever filmed. As you would expect, with so many planes milling around in close proximity, there were a number of mid-air collisions during the filming of this scene. Although a number of planes were lost, there were no serious injuries to the pilots. One stuntman was lost, however, when he failed to bail out of the spinning Gotha (a Sikorsky S-29) before it crashed. He was in the aft section operating the smoke pots and he did not hear the signal to jump.

Probably the most sincere compliment to the air scenes in *Hell's Angels* is their use in many of the later World War I aviation films. Lt. von Bruen, in his black Fokker marked with a skull and crossbones, is the bad guy in many subsequent films.

One of the best of the World War I films is *Dawn Patrol* with Errol Flynn and David Niven, made in 1938. It was a remake of an earlier 1930 film and used many of the same aerial scenes, including a few from *Hell's Angels*. Interestingly, *Dawn Patrol* was again rewritten, this time in a World War II setting, and appeared as *Fighting Squadron* in 1948. Apparently, filmmakers' perceptions of the problems of wartime command do not change with the change of equipment in wars.

There were many good aviation films



made in the 1930s with themes other than World War I. These include *Devildogs of the Air*, *Ceiling Zero*, *Test Pilot*, *Only Angels Have Wings* and *Hell Divers*. (Notice that Hell, Devils and Angels appear frequently in the titles of aviation films.) Major actors such as James Cagney, Cary Grant, William Holden, and Clark Gable starred in these films. It was a bit of a letdown to discover that James Cagney, the most brash and reckless of film pilots, actually does not fly, even on airlines, if he can avoid it. His "flying" scenes were made possible by what are called process shots. The star is filmed in an aircraft cockpit mounted on a movable stand in front of a large movie screen onto which is projected an in-flight scene as a backdrop. The distance scenes were, of course, flown by movie

stunt pilots.

There were few notable flying films made during World War II, but a number of fine films based on World War II flying were made after the war. One of the best was *Twelve O'Clock High*, filmed in 1949, a study of the stresses of command in the B-17 Groups of the Eighth Air Force. It is so well done that it is used regularly in leadership courses at the U.S. Air Force Academy. It was filmed with the full cooperation of the Air Force, which provided 12 B-17s complete with crews, and the use of auxiliary fields at Eglin AF Base, FL, and Ozark, AL.

Although the takeoff and landing sequences and formation scenes were flown by Air Force pilots, a movie stunt pilot, Paul Mantz, was needed for the crash landing of a B-17. Mantz, who also flew the B-25 camera plane for the film, and his partner Frank Tallman did much of the movie stunt flying after World War II. Their Tallmantz Company provided vintage aircraft and camera planes as well as pilots.

One of their most spectacular stunts was performed for *It's a Mad, Mad Mad Mad World*. In it, Tallman flew a Twin Beech through a billboard with only a few feet to spare on either side. Had the plane hit the steel framework it would most likely have crashed.

For the 1957 film *The Spirit of St. Louis*, Tallmantz had seven reproductions of Lindbergh's plane built from the original plans. There is a story, perhaps apocryphal, that Mantz and Tallman were very disappointed with the flying characteristics of the reproduction *Spirits*. They went back to the plans again and again to try to improve the stability. Finally they asked Lindbergh himself to fly one of the reproductions. He did and when he landed he pronounced it perfect since it flew just like the original.

Flying an old Pitcairn Mailwing, stunt pilot Paul Mantz flies under the Williamsburg bridge in New York for the 1947 film *Blaze of Noon*. Mantz was later killed in a 1965 crash while filming *Flight of the Phoenix*.



Unfortunately, both Paul Mantz and Frank Tallman were killed in aircraft accidents. Mantz was killed in 1965 in the crash of a hybrid plane while filming *Flight of the Phoenix*, and Tallman crashed in 1978 while scouting for a location site.

In more recent years, despite the great advances in the art of creating special effects for movies, a great deal of money has been spent to locate or reproduce older airplanes to fly in films. Producers and directors have rightly concluded that only real airplanes look like real airplanes on the screen. The producers of the major film spectacles, *The Blue Max*, *Those Magnificent Men in Their Flying Machines*, *The Battle of Britain* and *Tora, Tora, Tora* expended considerable time and effort and money to make the films as authentic as possible.

For the 1965 film, *Those Magnificent Men in Their Flying Machines*, a light-hearted film about an international air race prior to World War I, a number of reproductions of aircraft of the period were constructed. These included the Antoinette, Demoiselle, Avro Triplane IV, Bristol Boxkite and several of dubious parentage. The reproductions were as authentic as possible to the eye but for safety reasons modern construction materials and engines were used. The 1966 film, *The Blue Max*, told the story of a German World War I fighter pilot's quest for the coveted "Blue Max," the *Pour le Merite*, Imperial Germany's highest award. Nine reproductions of World War I fighters were used in the film, three Fokker Dr. Is, three Pfalz D. IIIs and three British S.E. 5s. The other aircraft in the film both British and German were barely disguised Belgian Stampe biplanes.

The Battle of Britain, a 1969 documentary-type film on that decisive conflict fought over England, included some 40 minutes of the most striking air battle sequences ever filmed. A large group of Spitfire and Hurricane fighters were assembled from all over the world to represent the Royal Air Force. The Luftwaffe Messerschmitt Bf. 109 fighters (actually Hispano HA 1112s) and Heinkel 111 bombers were bought from the Spanish Air Force which had flown them for many years after World War II. The German (Spanish) aircraft were powered by Rolls-Royce engines instead of their original German engines.

Full-scale fiberglass models of many of the British planes were built and used for ground scenes. Many were blown up in the bombing raids. All of the flying scenes used real airplanes except that models were used in the scenes where the aircraft exploded in the air, and for some of the crashes. The planes were flown by an international coterie of pilots including many from the Confederate Air Force in TX.



Japanese Zeroes in the 1980 movie *Final Countdown*. Actually, these planes were AT-6s modified into Zeroes, and they had been used previously in the 1970 movie *Tora, Tora, Tora*. In this picture they were flown by members of the Confederate Air Force, a flying museum which is based in Texas.

The construction of the aircraft representing the Japanese Zeroes, Vals and Kates, used in the 1970 film about the attack on Pearl Harbor, *Tora, Tora, Tora* was accomplished in a somewhat novel manner. Because authentic Japanese aircraft were unattainable in the numbers required for the film, the producers decided to modify U.S. World War II training planes into configurations resembling the required Japanese planes. North American AT-6 (Navy SNJ) advanced trainers were modified to resemble Zero fighters while Vultee BT-

13 basic trainers were modified to appear as Val dive bombers. The Kate torpedo bombers were made from combinations of AT-6 and BT-1e fuselages. Fiberglass fairings were used extensively to change wing and rudder contours. Five B-17s still in use as insect sprayers and anti-forest fire borate bombers were rented for the duration of the film. The pilots, called the Fox Air Force (from Twentieth-Century Fox), included both civilians and off-duty military. There were some 70 aircraft in the "airforce."

One of the most recent aviation films is *Final Countdown*, released in 1980. Although there is a science fiction angle to the film, in which a present day aircraft carrier passes through a violent electrical storm that moves it back in time to the day preceding Pearl Harbor, it primarily deals with flying. There are some wonderful combat scenes between the Navy's first line fighters, Grumman F-14 Tomcats, and the reproduction Zeroes from *Tora, Tora, Tora*. The film also provides a first-hand view of modern carrier operations. The Tomcats were flown by pilots of a crack Navy squadron, VF-84, "The Jolly Rogers," while the Zeroes were flown by pilots from the Confederate Air Force.

Since the first aviation films were shot in the World War I era through to the present, there have been many advances in aircraft performance, motion picture equipment and special effects techniques. There has been one constant, however, the need for and use of highly skilled, courageous pilots and cameramen. Without them the exciting films that we all enjoy would not have been possible.

One footnote to the story of aviation films is their continued popularity. Every fall the National Air and Space Museum runs a free evening series featuring these films. The series consistently draws large and enthusiastic crowds. ■



Safe on the ground, actor William Bendix who was a star of *Blaze of Noon*, is hoisted into the cockpit upside down for an inverted shot in the studio.

Freedom 7

Twentieth anniversary of the first American in space

Gregory Kennedy
Space Science and Exploration Department
NASM

On May 5, 1961, Alan Shepard became the first American in space during his 15-minute sub-orbital (ballistic) flight in the spacecraft *Freedom 7*, a flight which was to be the start of many remarkable accomplishments for Americans in space during the next 20 years.

Project Mercury. The goals for America's first manned space project had been defined back in October of 1958—to achieve orbital flight and recovery of a manned satellite, and to investigate man's ability to survive in space. Then,

in October of that year, the project was named Mercury, who in Roman mythology was the messenger of the gods.

Mercury officials made the initial decision to use military rockets as launch vehicles in order to accelerate the program, and they selected the Air Force's Atlas intercontinental missile to propel the spacecraft. For shorter sub-orbital "up and down" test flights they chose the smaller Redstone missile which had been developed by the Army.

The Mercury spacecraft was bell-shaped, 2.7 meters (9 feet) high and 1.8 meters (6 feet) in diameter at its base. The conical lower section housed the craft's single occupant and his equipment. There were two parachutes in the cylindrical upper section, one primary and one backup. An ablative heat shield on the spacecraft was designed to protect it during atmospheric entry. Three solid-fuel retrorockets strapped to the heat shield were to be fired in order to slow the craft sufficiently to enter the atmosphere.

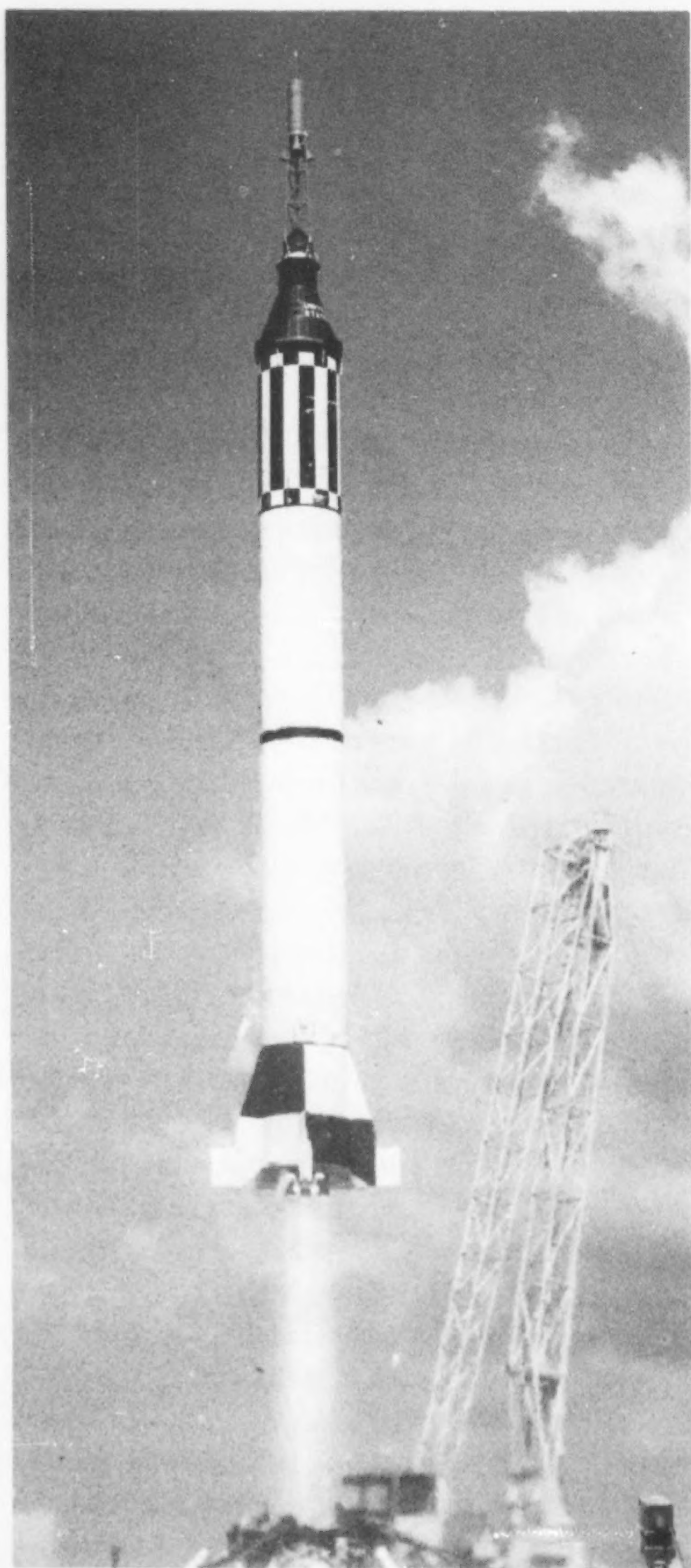
In addition, there was a launch escape

system consisting of a tower topped with a solid fuel rocket motor attached to Mercury's front end. If the launch vehicle malfunctioned during launch this motor could pull the spacecraft away for a safe landing. Once the craft reached a safe altitude the escape system would be jettisoned.

Freedom 7. In April of 1959 seven men were named as pilots for the Mercury spacecraft project: M. Scott Carpenter, L. Gordon Cooper, Jr., John H. Glenn, Jr., Virgil I. Grissom, Walter M. Schirra, Donald K. Slayton, and Alan B. Shepard, Jr. These American pioneers in space were called "astronauts," a word developed from "argonauts," who were the legendary Greeks who searched for the Golden Fleece.

The astronauts worked for two years with the project engineers and technicians in preparing for a successful space flight. Early testing consisted of unmanned flights of spacecraft with monkeys on board, but by April of 1961 the project officials felt they were ready for a Mercury flight with a human passenger. The first flight was to be a shakedown flight to verify the craft's spacworthiness, and it would not orbit the Earth; rather, it would be a sub-orbital flight to an altitude of 115 miles. And the Redstone would propel the spacecraft to a velocity of slightly over 5000 miles per hour, less than one-third the speed needed to achieve orbit.

Just a few weeks before the proposed American flight, on April 12, the Russians suddenly announced that Major Yuri Gagarin of the Soviet Air Force had orbited the Earth in a spacecraft named



The launch of Freedom 7 on May 5, 1961.



Alan Shepard being hoisted from Freedom 7 into a Marine helicopter after his successful flight.

Vostok-1, becoming the first human being to fly into space. It was electrifying news, similar to the announcement four years earlier of the Russians' *Sputnik 1*, the first man-made spacecraft into orbit around the Earth. Undaunted, the American team continued to make preparations to catch up with (and eventually surpass) the Russian accomplishments.



Alan B. Shepard, the first American in space.

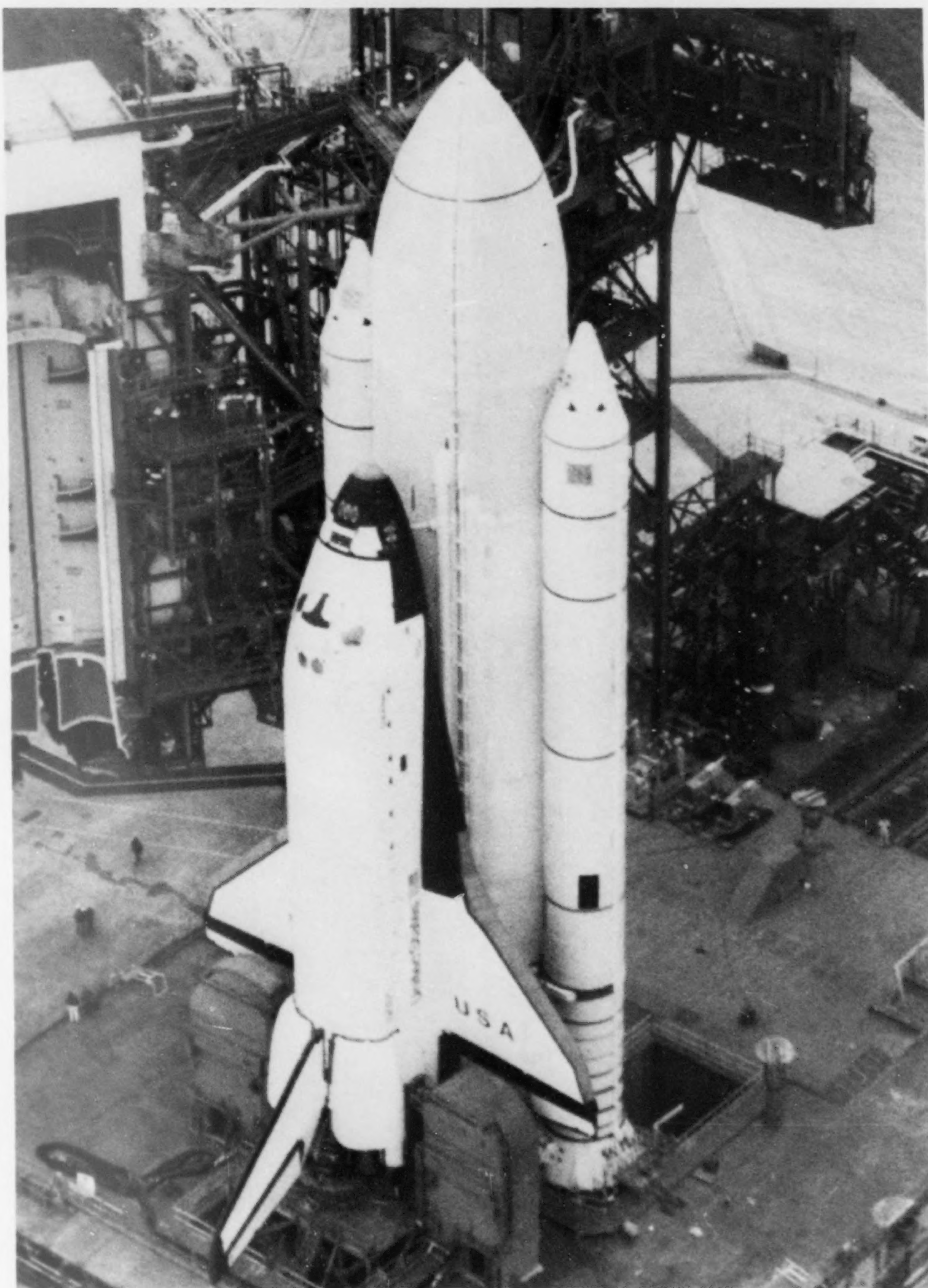
Alan Shepard was selected as America's first astronaut, and he named the spacecraft *Freedom 7*. May 2 was chosen as the launch date at Cape Canaveral, FL, but it was postponed until May 5 because of inclement weather.

Shepard entered the spacecraft at 5:15 that morning, and over four hours later at 9:34 lift-off occurred. The Redstone engine shut down on schedule 142 seconds after lift-off. The launch escape system was jettisoned, and *Freedom 7* separated from the spent booster. It was now moving at a velocity of 5134 miles per hour, and the pilot was able to control the spacecraft's movements about all three major axes—pitch, yaw, and roll.

Freedom 7 reached a peak altitude of 133 kilometers (116.5 miles). Shortly after reaching the zenith of his trajectory on the brief flight, Shepard prepared for reentry. At 3048 meters (10,000 feet) the main parachute was released and the spacecraft completed its journey at a speed of 35 feet-per-second. It splashed down in the Atlantic Ocean 486 kilometers (302 miles) from Cape Canaveral, just 15 minutes and 22 seconds after launch. Both Shepard and *Freedom 7* were retrieved by helicopter and taken to the aircraft carrier *USS Lake Champlain*.

The American space program continued, of course, and other astronauts were to follow Shepard into space—notably Neil Armstrong and Edwin Aldrin who walked on the Moon in 1969—but *Freedom 7* was the beginning. ■

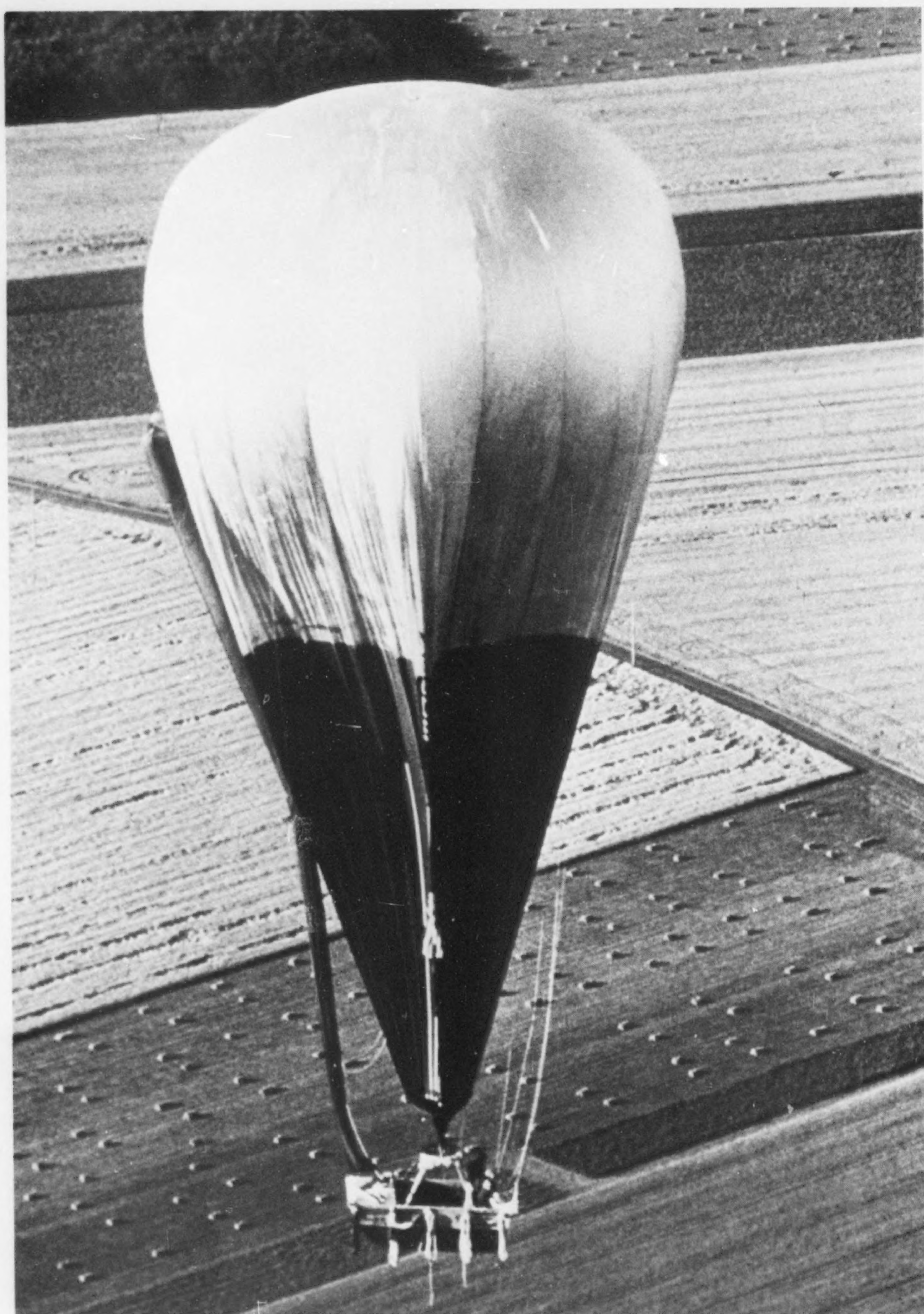
Related Flight series filmstrip:
Rocketry and Space Flight (see page 18).



The Space Shuttle assembly on the launch pad at Kennedy Space Center. The assembly consists of the space orbiter Columbia (in the forefront in this picture, and marked with the letters U S A); the external tank (in the center, the tallest part of the assembly); and two solid fuel rocket boosters (flanking the external tank). During the flight the boosters were jettisoned, followed by the tank, and then the Columbia continued its journey into space. Columbia's first flight was made on April 12-14 of this year.

The Space Shuttle

An exhibit on the Space Shuttle opened in April in NASM's Space Hall. Items on display include an impressive 4.9 meter (16 foot) model of the Space Shuttle *Columbia* on its launch pad, thermal protection tiles from the exterior of the shuttle, and models of future payloads. The Space Shuttle, the most complex flying machine ever built, is the first reusable manned space vehicle. *Columbia* is to be one of a fleet of shuttles, with four or five ships in operation by the mid-1980s as a versatile space transportation system. NASM's new exhibit is called "America's Space Truck—the Space Shuttle."



The Double Eagle II soars over the French countryside.

Double Eagle II

*The first flight across
the Atlantic in a balloon*

Claudia M. Oakes
Assistant Curator
Department of Aeronautics, NASM

Since the very early days of aviation, many pilots have been stricken with "Atlantic fever", the dream of crossing the Atlantic Ocean by balloon. It is difficult to determine just how many actual attempts there have been to make this balloon crossing, especially some of the 19th century exploits, because questions arise as to which were real attempts, which were practice flights, and which were just experiments.

What is certain, however, is that until the *Double Eagle II* landed in a field in France on August 17, 1978, this dream had remained unfulfilled.

Related Flight series filmstrip:
Balloons and Airships (see page 18).

Ben Abruzzo, Maxie Anderson, and Larry Newman, all of Albuquerque, NM, made the 4988-kilometer (3100-mile) flight from Presque Isle, ME, to a field near Miserey, France, about 96.5 kilometers (60 miles) northwest of Paris, in 137 hours, 6 minutes. Their helium-filled balloon, the *Double Eagle II*, was 112 feet high, 65 feet in diameter, and had a capacity of 160,000 cubic feet. Abruzzo, Anderson, and Newman rode in a 15-by-7-by-4½ foot gondola named the *Spirit of Albuquerque*. This gondola was the same one used by Anderson and Abruzzo in a prior attempt at crossing the Atlantic by balloon in 1977.

On that trip they were forced to set down on the water three miles off the northwest coast of Iceland, after they were unable to maintain altitude because of severe downdrafts and ice on

the balloon envelope.

Their lives were saved in great part due to the fact that the lightweight gondola was built as a twin-hulled catamaran that would float in case of an emergency water landing.

During the successful 1978 flight, Larry Newman, a hang glider pilot and manufacturer, carried along a hang glider attached to the gondola with the idea of ending the flight by descending by glider. However, the glider had to be jettisoned to lighten the balloon before they reached their goal.

The red and yellow gondola held enough oxygen for the crew for four days and sufficient food and water for 30 days. The balloon and gondola were manufactured by Ed Yost of Tea, SD, who himself had made an unsuccessful transatlantic ballooning attempt in 1976.

On July 25, 1978, the envelope was inflated inside the Hippodrome Coliseum in St. Paul, MN, to test for pinhole leaks.

At 5:35 A.M. on August 11, 1978, inflation of the *Double Eagle II* began in a clover field outside Presque Isle, ME. Liftoff was delayed about two and a half hours because of a shortage of helium. Because of weather conditions, this meant that the balloon's potential endurance was shortened by a day.

Communications equipment on board included a VHF radio, two single side-band HF radios, an ADF beacon transmitter, an amateur band radio, a marine radio, and a hook-in to the Nimbus 6 satellite which transmitted their latitude and longitude to Goddard Space Flight Center in Greenbelt, MD.

Officially, the Atlantic crossing was attained at 10:02 P.M. on August 16, when the *Double Eagle II* crossed the Irish coast. But the goal of the three aeronauts was Le Bourget Airfield near Paris, where Lindbergh had landed in 1927. Late in the afternoon of August 17, however, the pilots made the decision to land in the French province of Normandy. At 7:48 P.M. the *Double Eagle II* touched down in a wheat field near Miserey and was immediately surrounded by crowds of people who had been following the balloon's path.

During the crossing, the *Double Eagle II*'s altitude varied from a low point of 1067 meters (3500 feet) on August 13 when clouds screened the Sun and cooled the gas, causing the balloon to



Ben Abruzzo, Larry Newman, and Maxie Anderson say good-bye to family and friends prior to lift-off.

sink, to a high point of 7604 meters (24,950 feet) on August 16.

The success of the *Double Eagle II*, after so many others had failed, can only be attributed to 20th-century technology, better understanding of weather patterns, and the skill and experience of the pilots. ■



Left, NASM museum technician Gary Cline works on the gondola of the *Double Eagle II* to prepare it for exhibition in the Museum. Right, the *Double Eagle II* as it today appears on exhibit in NASM's "Balloons and Airships" gallery.



Saturn

Lord of the rings

Robert W. Wolfe
Geologist, NASM



Saturn and its satellites in this mosaic of images taken by Voyager I in 1980.

Everyone's favorite planet, Saturn, with its beautiful system of rings, is what a planet *ought* to look like. Ask any child to draw a planet and Saturn is what you get, as surely as stars are drawn five-pointed. Saturn was *the* ringed world—exclusive, mysterious, unique—at least until the discovery of Uranus' rings in 1977 and the Jupiter ring last year.

But it was not always so. Saturn was just one of the five planets known to ancient peoples, distinguished only in being the most distant from Earth. To the naked eye, the rings were indiscernable. Not until 1610 was Saturn known as anything more than a point of light.

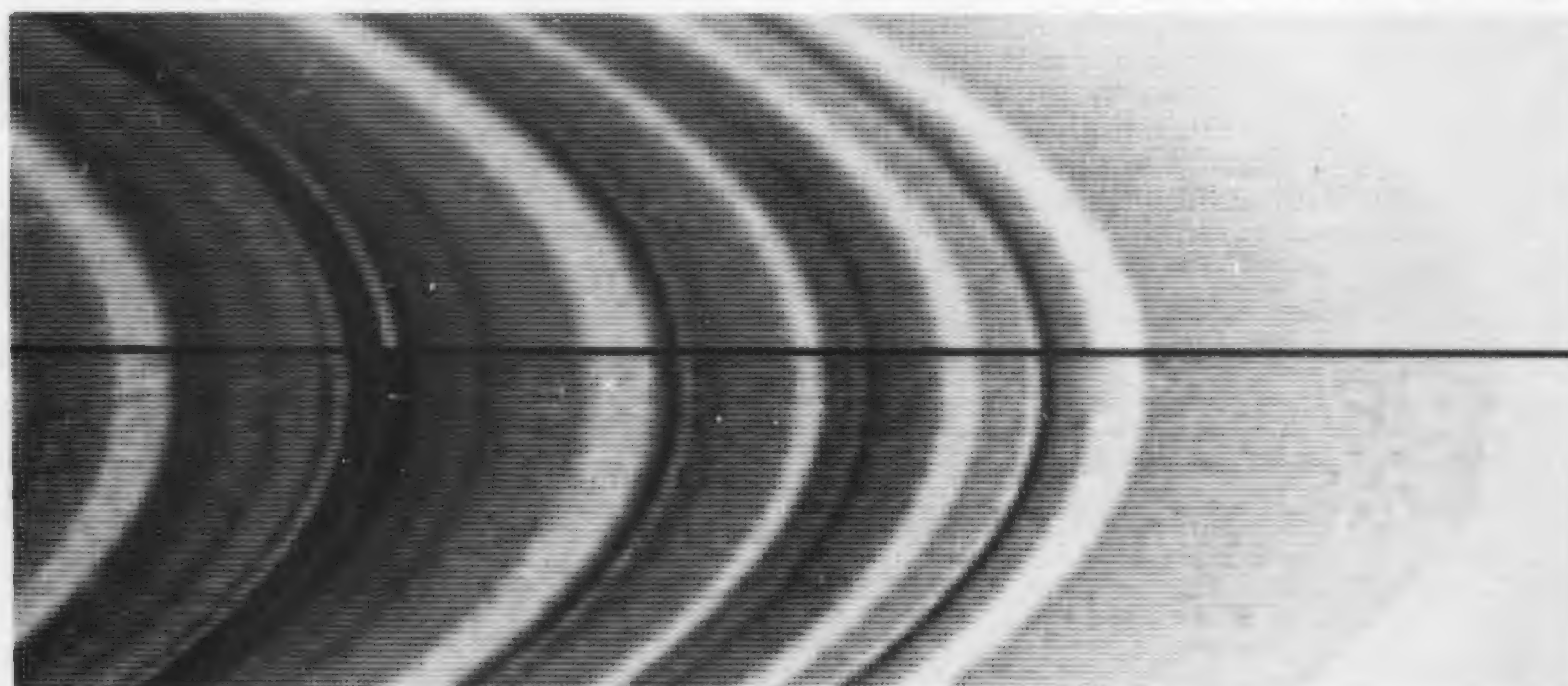
Using his largest telescope, Galileo discovered Saturn's rings. More accurately, he discovered "a most extraordinary marvel . . . that the planet Saturn is not one alone, but is composed of three." Galileo did not grasp the nature of what he saw. Nor did numerous observers over the next half century who saw Saturn as many things. In part, this may be because their instruments were crude; in part because they could not conceive of a planet with rings, something beyond all experience. Perhaps too, it is because Saturn presents different views to Earth when in different parts of its orbit. The puzzle was finally solved by the noted Dutch scientist Christian

Huygens in 1655.

Twenty years later, Jean Dominique Cassini noted that "... the breadth of the ring was divided into two parts by a dark line [now called Cassini's Division] as if into two concentric rings, the inner of which [now called the B ring] was brighter than the outer one [the A ring]." Over the following centuries, more divisions and rings would be discovered.

In this book *Systema Saturnium*, Huygens had drawn Saturn as though the ring were a flat, solid disc. Although there were other ideas, this was the prevalent view for about two centuries. Then, in 1859, the young English physicist James Clerk Maxwell showed it could not be so. Under the influence of gravity, inner portions of the ring would rotate more rapidly than the outer reaches. Any solid body would be torn apart. The only stable configuration for the ring, Maxwell proved, would be one of innumerable small objects, each in its own orbit about Saturn—each a tiny moon.

In 1895, the American astronomer James Keller verified the nature of Saturn's ring with observational proof. No, he did not see the individual particles. Even today, as closely as spacecraft have passed by the ring, the pieces that comprise it have not been seen. Instead, what Keller did was to determine the orbital velocity of different parts of the ring by measuring the Doppler shift of spectral lines. (For an exercise on this

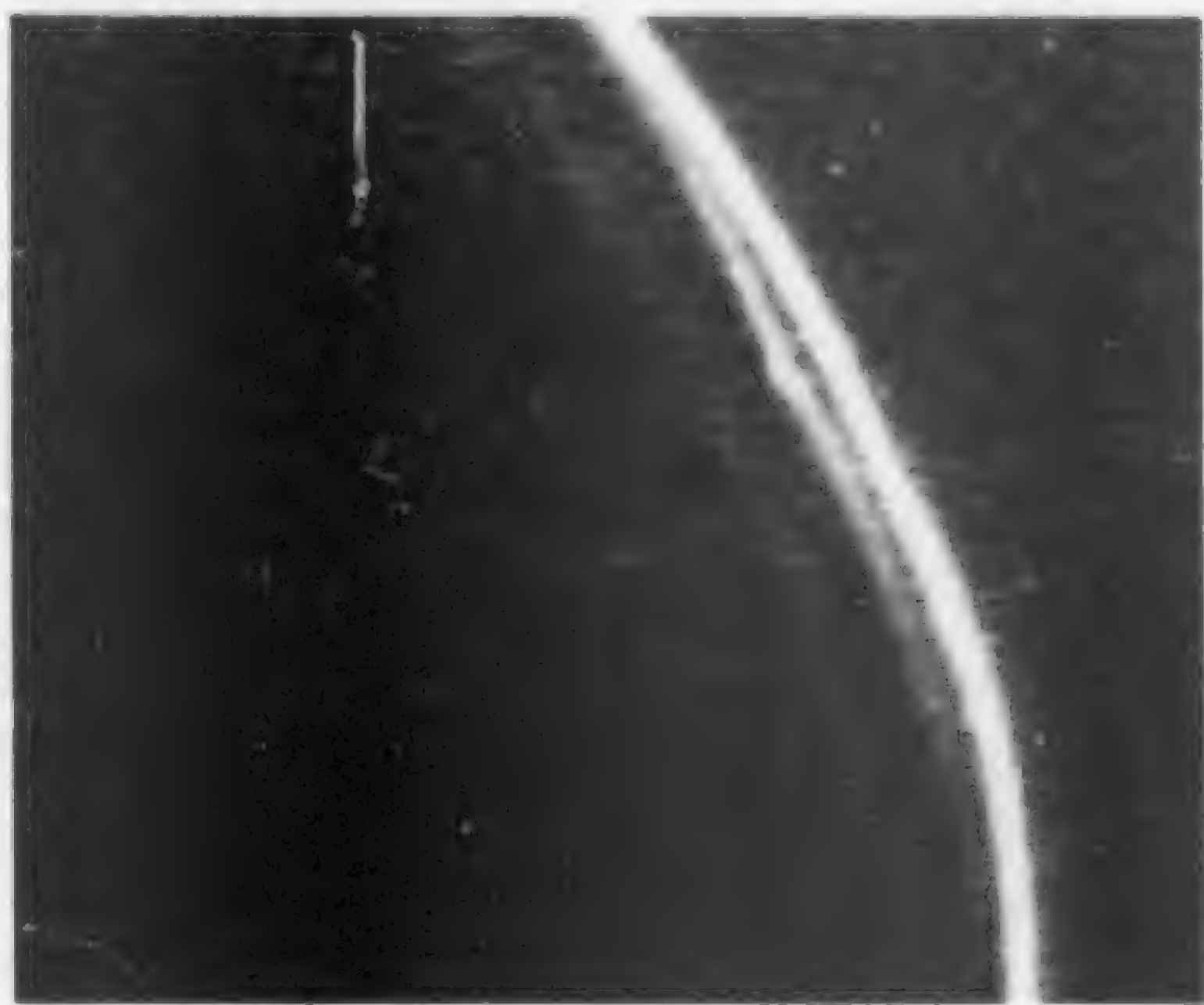


Composite photo of Saturn's rings made of one image from each side of the planet. Near the center is a narrow ringlet that does not match, indicating an eccentric, elliptical orbit, rather than one which is circular.

topic, suitable for high school or college students, see *Sky and Telescope*, November 1964, pp. 278-279.) In complete agreement with Maxwell's theory, the ring exhibited a range of velocities, exactly those that would be expected if the ring were comprised of a host of particles, each obeying Kepler's Laws of Motion.

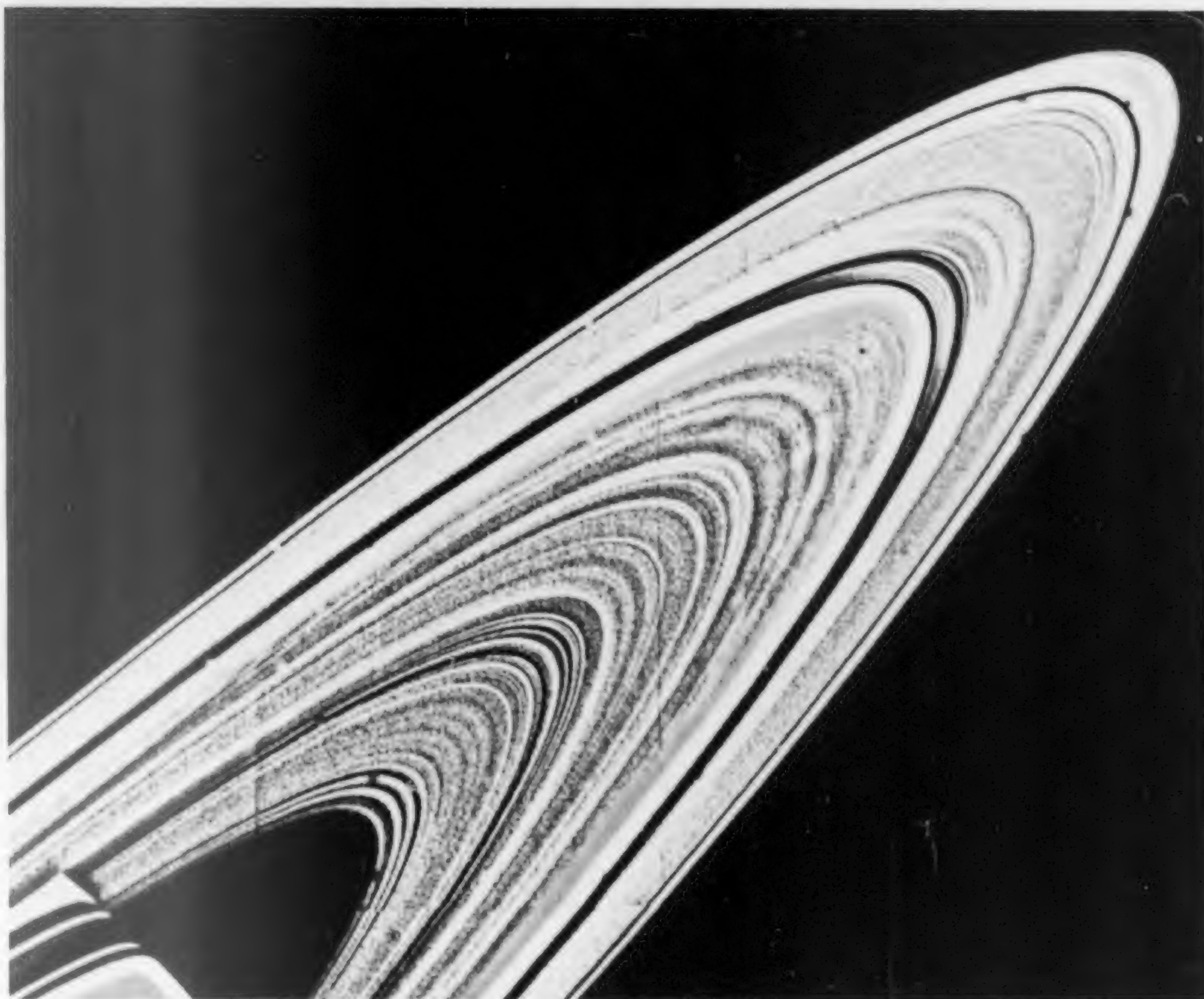
In August 1980, the *Voyager 1* spacecraft was close enough to Saturn that its cameras and other instruments began to view the planet in more detail than could be obtained from Earth. Startling and unexpected features were seen in the rings almost immediately.

Strange, dark, radial markings rotated with the rings like the spokes of a wheel. Possible explanations for the spokes abounded, but it would require months of detailed observations to rule out all but a few of the most likely theories. Are the spokes clots of dark, less reflective ring material; are they regions where ring particles are relatively scarce; are they concentrations of certain sizes of particles that reflected light differently from the surrounding particles? Eventually, the last option was chosen, after the rings had been viewed from many different directions and under many different lighting conditions. Do the spokes rotate with the ring particles or under the influence of Saturn's magnetic field? If it were the former, then rotational



Saturn's F ring consists of two narrow, braided rings, and a third, broader, very diffuse component.

period (time required to complete one rotation) would range from $5\frac{1}{2}$ to $14\frac{1}{2}$ hours depending on how far the spokes were from the planet. If the rotation were with the magnetic field, the period would be 10 hours, 40 minutes, the rotation period of Saturn. The puzzle would not, however, yield its solution so easily; the spokes were in that portion of the ring having orbital periods approximately the same as Saturn's period. Again, the answers came only after months of careful observation. Strangely, both gravitational (orbital) and magnetic forces were found to influence the motion of the spokes.



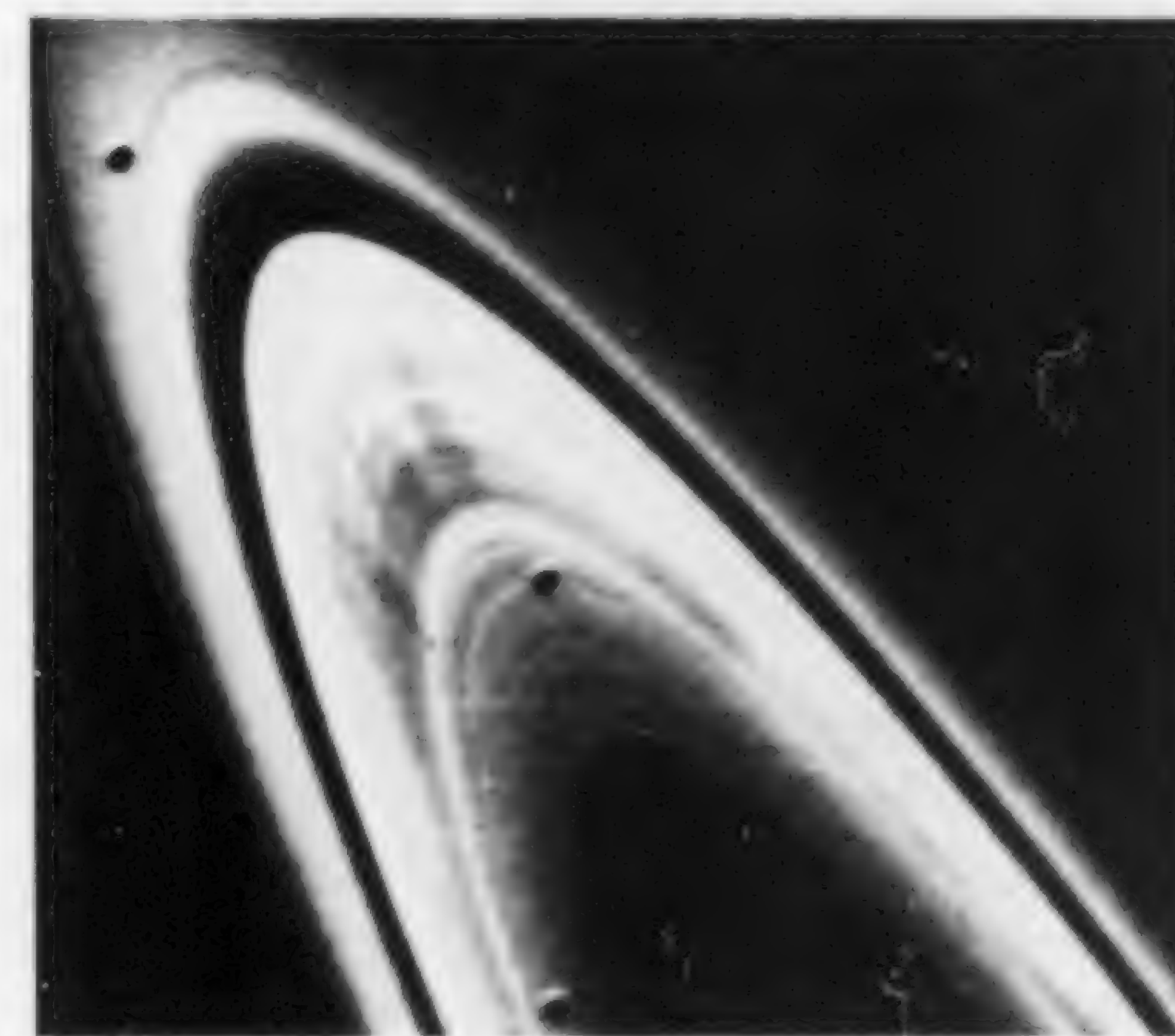
A mosaic of Saturn's rings which shows approximately 95 individual concentric features.

As the *Voyager* spacecraft bore closer and closer to Saturn, the amount of structure discernable in the rings grew daily. Instead of the three, featureless, bright rings known to telescopic observers, the number of ringlets increased daily. Dr. Bradford Smith, the imaging team leader, remarked that team scientists stopped counting after about 300 ringlets were visible.

Buried among the new-found richness of detail were some surprises. The Cassini division, once thought devoid of particles, is occupied by several narrow ringlets, each separated by a small division. How fortunate it was that the proposed path for the *Pioneer 11* spacecraft, through the Cassini division, was not selected. Although nearly all the ringlets lie in the same plane and describe nearly circular orbits encircling Saturn's equator, a few behave quite differently. Some have elliptical orbits, some vary in thickness, some have orbits that are inclined. What causes these ringlets to be so different is not yet understood, but it probably has something to do with gravitational interactions with other ringlets and with Saturn's innermost large moons Mimas and Enceladus.

The real oddball is the F ring that lies just outside the major ring system. *Voyager 1* was on its way to Saturn after a spectacular rendezvous with Jupiter when the F ring was discovered by *Pioneer 11* in September 1979. *Voyager's* onboard computers were reprogrammed to include observations of this myste-

rious, thin ring . . . mysterious because a thin, isolated ring should not exist, theory said, unless there were some small moons nearby to hold the ring together gravitationally. Its cameras pointed toward the F ring and *Voyager* soon found them . . . two, small, previously unknown moons—Saturn's fourteenth and



Dark spoke-like features in Saturn's rings revolve around the planet with the rings' orbital motion.

fifteenth. The F ring itself was revealed to be something unheard of and unimagined—not one thin ring, but three, two of which are twisted or braided together. *Voyager 2*, due at Saturn in August 1981, is being reprogrammed to take a closer look at the F ring. Still, it may be years until all the puzzles of Saturn's rings—puzzles we did not even know about a year ago—are unraveled. ■



The legendary Jacqueline Cochran stands beside the Northrop T-38 in which she set several of her many speed records.

Women in Modern Aviation

Claudia M. Oakes

The years following World War II saw many aircraft speed and altitude records being shattered thanks to the technology developed during the war years. Women were as active in these attempts to break records as men, and foremost among them was Jacqueline Cochran, who had established the Women Airforce Service Pilots (WASP) program during the war. For that work, she was awarded the Distinguished Service Medal in 1945. (See article titled "Women Airforce Service Pilots" in the Spring 1981 issue.)

In 1950, Cochran set a new absolute international speed record for propeller-driven airplanes when she piloted her P-51 around a 500 kilometer (311 mile) closed course at 444 miles per hour. Prior to that flight, she had held three international speed records and in 1953 set three more. Also in 1953, she became the first woman to fly faster than the speed of sound, in an F-86 Sabre Jet at Edwards AFB, CA.

Forty-nine new aviation records were set in April 1962 during Cochran's 8238 kilometer (5120 mile) flight from New Orleans to Hanover, West Germany, in her Lockheed Jetstar *Scarlett O'Hara*. In addition to record-setting times and speeds during the 13-hour 40-minute flight, her main record was an interna-

tional mark for distance in a jet piloted by a woman, 3667 kilometers (2279 miles) from New Orleans to Gander, Newfoundland.

Cochran continued to set and break records until she retired from flying in the early 1970s. Among her more significant later records was a new world speed for women of 1429 miles per hour set in 1964 in an F-104G.

Another woman who seemed to make a habit of setting records in the 1950s

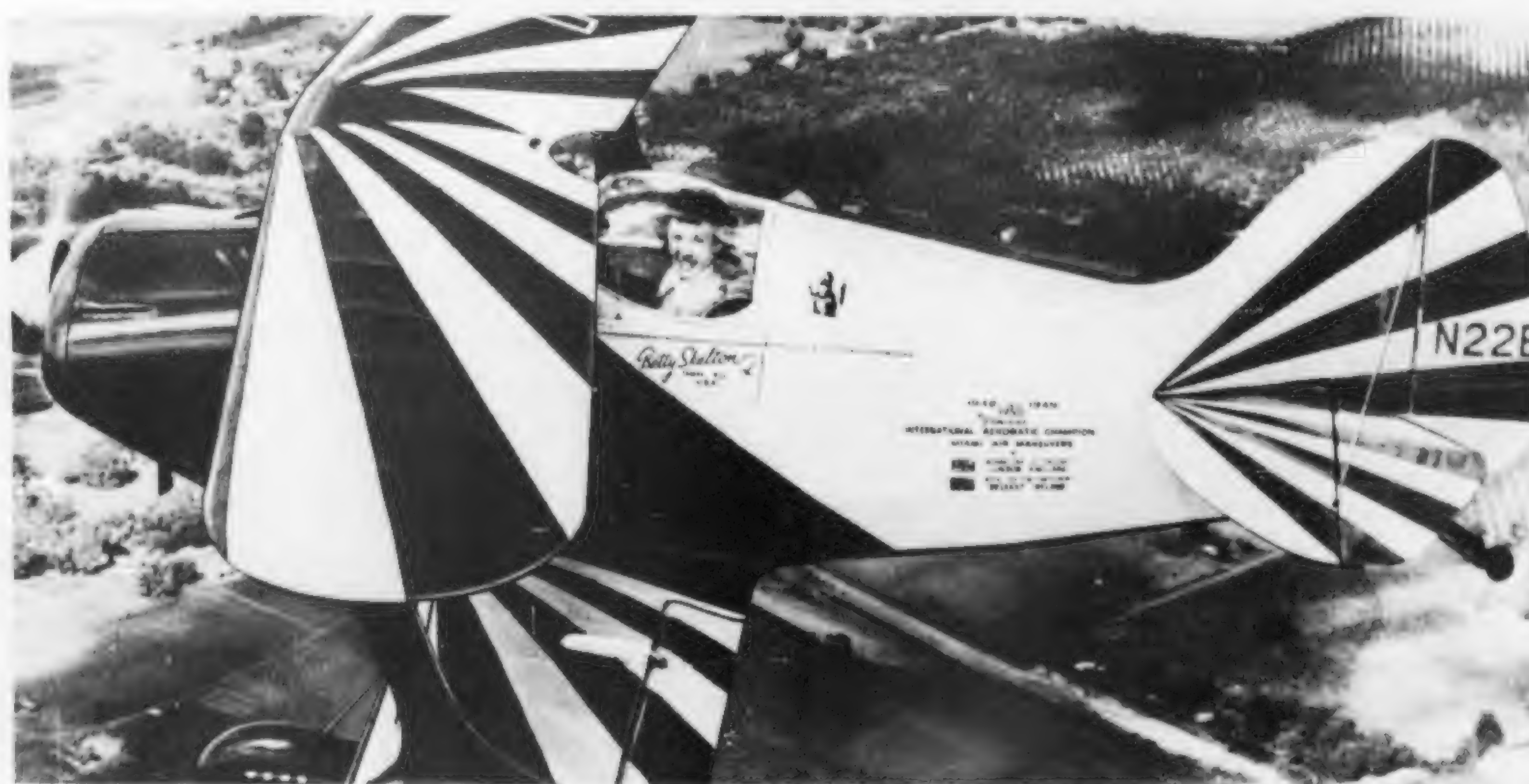
and 1960s was Jerrie Cobb, Director of Advertising and Sales Promotion for the Aero Design and Engineering Co. of Oklahoma City. Flying an Aero Commander, she set a distance record of 2420 kilometers (1504.74 miles) in 1957, a speed record for the airplane's class of 226.148 miles per hour in 1959, and an altitude record of 11,280 meters (37,010 feet) in 1960. In 1961, she was the first and only woman picked by the Mercury Astronaut Selection team to undergo the same physical, psychological, and stress tests as the astronauts. She served for two years as a consultant to



Lt. Lynn Spruill was the first woman in the U.S. Navy to qualify for air carrier flying.

NASA and for several years flew into the unexplored areas of South America to take the natives supplies and medical help.

A major aviation achievement by a woman occurred in 1964, when Geraldine Mock of Columbus, OH, became the first woman to pilot an aircraft around the world. She flew her Cessna 180 *Spirit of Columbus* 37,173 kilometers (23,103 miles) from Columbus and back in 29 days, 11 hours, 59 minutes. The aircraft is now displayed in the General Aviation Gallery of the National Air and Space Museum.



The only woman ever to win the women's World Aerobatic Championship three times in a row, 1948, 1949, and 1950, was Betty Skelton Frankman, flying her Pitts Special "Lil' Stinker".

Besides setting records, women began moving into positions of importance in the aviation industry. Olive Ann Beech is Chairman of the Board of Beech Aircraft; Dr. Dora Strother is Chief of Bell Helicopter Textron's Human Factors Division and Cockpit Arrangement Group; Shirley Holmgreen of The Boeing Company is group supervisor for the 737 Aerodynamics Staff and 727/737 Product Development.

The first woman pilot for a regularly scheduled U.S. airline was Emily Howell Warner who began flying for Frontier Airlines in 1973. She is now a Captain on Twin Otters and a First Officer on 737s for Frontier. As of May 1980, some 140 women were employed as pilots by U.S. airlines.



Jerrie Cobb was the first woman selected by NASA in 1961 to undergo the same tests as the Mercury astronauts.

In 1973, the Navy became the first branch of the U.S. military to open aviation training for women; the Army, the Air Force, and the Coast Guard soon followed. By late 1979, the Navy had 27 female pilots, the Army 40 (all rated in rotary-wing aircraft), the Air Force 22 officer pilots and six navigators, and the Coast Guard two helicopter pilots and a transport pilot. While these numbers may seem small in comparison with male military pilots, they nevertheless mark a great advance for women in aviation.

There is little in aviation today—whether in the airlines, the military, or the aeronautics industry—where women are not participating. ■



Since NASM's opening in 1976 nearly 45 million people have visited the Museum.

NASM's Fifth Anniversary

A new exhibit gallery, extended hours, and free concerts and workshops will be part of the fifth anniversary celebration scheduled for July 1-5 at the National Air and Space Museum.

On July 1, the Museum will remain open until midnight for a public birthday party. (Normal closing time for the month of July is 9 P.M.) Planned activities include free showings of the popular IMAX films, *To Fly* and *Living Planet*, as well as continuous free showings of the Museum's planetarium presentation, *New Eyes on the Universe*. Birthday cake and coffee and free parking in the Museum's garage will be added attractions.

Also on July 1, the Museum will open a major exhibit gallery, Jet Aviation. (See the article "Jet Aviation Gallery" on page 12 of the Spring issue.) The new gallery will include a Messerschmitt ME 262, the world's first operational jet fighter; a Lockheed XP-80, the first U.S. operational jet fighter; a McDonnell FH-1 Phantom, the world's first shipboard jet fighter and a Bede BD-51, a general aviation aircraft. Complementing the aircraft display is a large (20' x 75') mural painted by aviation artist Keith Ferris, featuring 27 significant planes of the jet age.

Other anniversary activities during July 1-5 will include free concerts and workshops and demonstrations in such areas as kite and model building. Admission, as always, is free.

Collier Trophy—1981

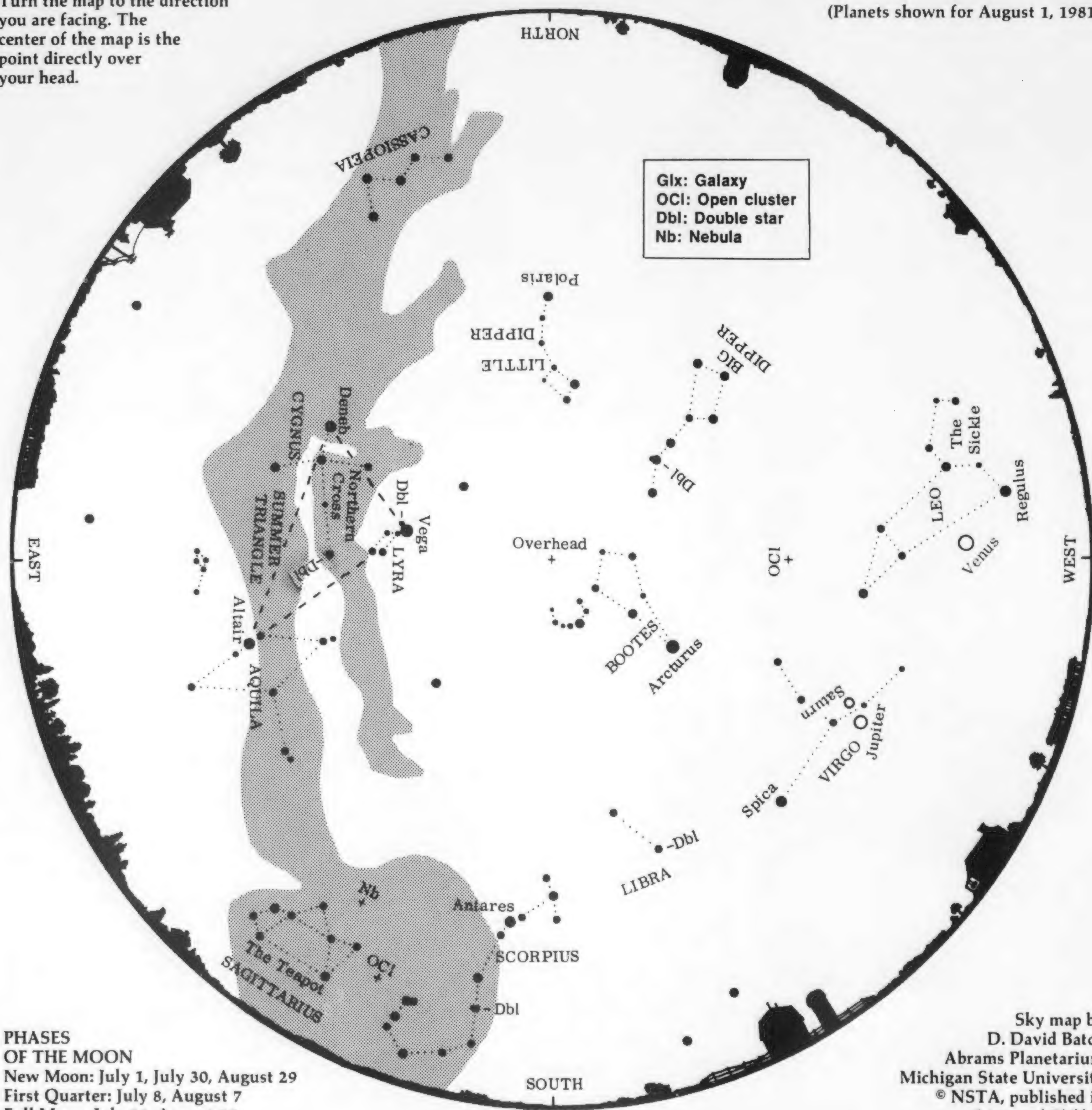
The Collier Trophy, the Nation's oldest aviation award, has been given this year to the *Voyager* Mission Team for its highly productive achievements in space-flight and space exploration. The *Voyager* program carried scientific and communication instruments through close encounters with the planets Jupiter and Saturn. To

achieve its remarkable accomplishments, the program had to develop a spacecraft system, instrumentation for the measurement of data, and a transmittal system for returning that data to Earth. The Collier Trophy was established in 1911, and it was first presented to Glen Curtiss for his achievements in developing a seaplane.

This circle represents the night sky as it appears in late July at 9:00 p.m. or early August at 8:00 p.m. Turn the map to the direction you are facing. The center of the map is the point directly over your head.

Summer Sky Map

(Planets shown for August 1, 1981)



PHASES OF THE MOON

New Moon: July 1, July 30, August 29
First Quarter: July 8, August 7
Full Moon: July 16, August 15
Last Quarter: July 24, August 22

by T.H. Callen II
Production Specialist
Albert Einstein Spacearium, NASM

It seems very fitting, now that spring has come, that our summer nights are graced with a collection of lively animals, a few of which we'll examine here. Starting low in the northeast, we can easily pick out the five stars making up the queen, Cassiopeia. If you were

an Eskimo living on the cold, arctic tundra, you would see in these stars five reindeer taking a drink in the Pebbly River. Can you guess what we call the Pebbly River? They think of the Milky Way's broad, diffuse band as the river's water, the fainter stars along it, pebbles at its bottom. The Galaxy appears as it does because we are looking from the inside toward the edge of a large disk of stars.

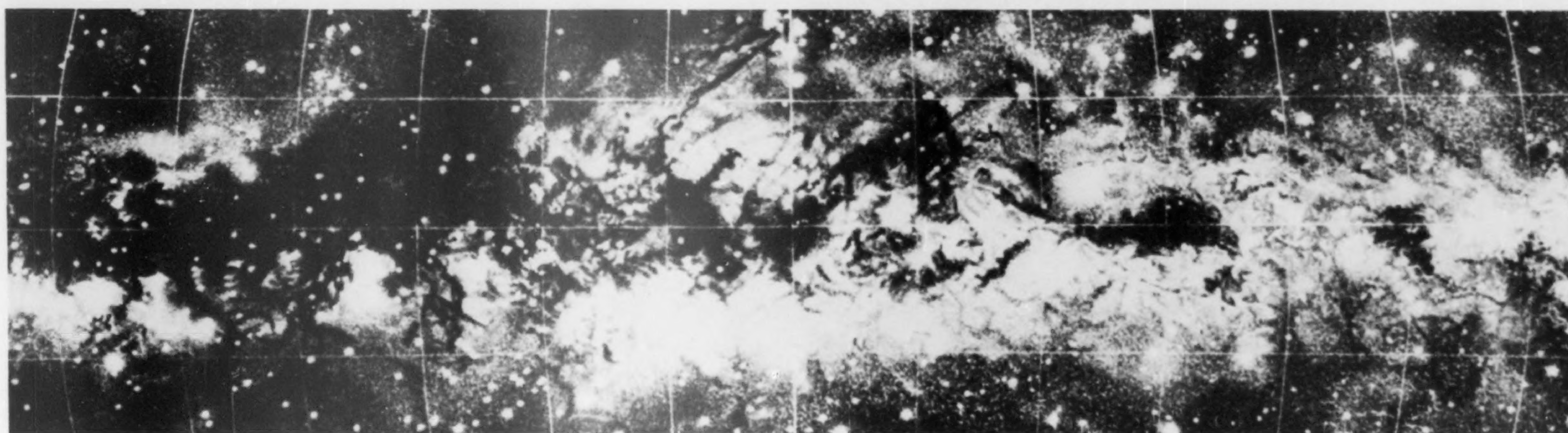
Moving along the Milky Way we come to the star Deneb, which marks the tail feathers of Cygnus, the Swan. The tip of Cygnus' bill is marked by the blue and yellow double

known as Alberio. Nearby is Vega, the brightest star in Lyra, the Harp, which was said to be made from a tortoise's shell.

Forming an apex of a large triangle with Deneb and Vega is the bright star Altair, the tail of a bird of prey, Aquila, The Eagle.

Finally, at the southeast horizon, we discover two mysterious creatures: Sagittarius, the centaurian Archer, and Scorpius, the Scorpion. Legend tells us that this half-man, half-horse being was the celebrated healer, educator, musician, and hunter, Chiron, the son of Saturn and Philyra.

Sky map by
D. David Batch
Abrams Planetarium
Michigan State University
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Science and Children
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The Milky Way

Silver river in the summer sky

Von Del Chamberlain
Astronomer, NASM

Not until last autumn did I fully realize why many early people referred to the Milky Way as a river in the sky. I had spent several days on the Green River in Utah, dodging rocks and shooting rapids. Then one night, as I slept on a sandy beach at the river's edge, I awoke and I could hear the water flowing past me, and there overhead was the river. I could pick out dark rocks and pools and brighter billowing rapids, all contained by an eroded shoreline. Only when I was fully awake did I realize I was actually looking up into the sky. The exquisite detail along the Milky Way gave me instant understanding of why the Akkadians, Chinese, Japanese, Arabians, Hebrews and other people had referred to the Milky Way as a celestial river.

I also realized how few people today see the Milky Way under such favorable conditions. Many people have never seen it at all and most seldom see it anymore. Human activities tend to remove us from the pristine natural world and even those who occasionally go there usually close themselves inside covers when darkness falls; we have been conditioned to close, not only our eyes, but even our minds to the night.

People at different times and places have had a variety of ideas about the band of starlight cleaving the sky. Some have thought of it as a path. Others have called it a road. Through much of human history it has been considered some type of channel to transport something to somewhere. The Indians of the American Prairie, for example, thought of it as the spirit pathway along which the souls of the dead passed in route to the hereafter located among the stars.

The name Milky Way comes from its whitish appearance, resembling milk splashed across the sky. The Greek word for milk is *galakt*, or *gala*. The Greek philosopher Eratosthenes (about 200 B.C.)

referred to it as the Circle of the Galaxy. One of the most important things we can learn about it is that it is, indeed, a complete circle around the sky. We see the most prominent part of that circle in the summer evening sky running from the horizon in the south, where we find the constellations Sagittarius and Scorpius, upward through the Summer Triangle and into Cassiopeia in the north (see sky chart on page 16). By December we can still see part of the Summer Triangle and Cassiopeia in the evening sky, but a whole new section of the Milky Way has come into view. This part is not as bright as the portion we see in the summer, but there is no question about it being a continuation of the Milky Way. It runs from Cassiopeia through Taurus and Auriga and on past Orion and Canis Major (see January sky chart in the Winter 1980 issue). In all, we see about two-thirds of the Milky Way from mid-northern latitudes. The rest never rises above our horizon and we must travel southward to see it. We can, however, see enough of the Milky Way to recognize the trend of the complete circle of the galaxy which Eratosthenes mentioned so long ago.

"It is astonishing," wrote the philosopher Immanuel Kant as he discussed the Milky Way in 1755, "that the observers of the heavens have not long since been moved . . . to deduce from it special determinations regarding the

position and distribution of the fixed stars. For it is seen to occupy the direction of a great circle, and to pass in uninterrupted connection round the whole heavens." He expressed surprise that the Milky Way which went completely around us had been so much ignored " . . . that attentive astronomers ought to have been thereby led, as a matter of course, to seek carefully for the explanation of such a phenomenon." Kant beautifully deduced the idea that we live inside a gigantic flattened assembly of stars whose light blends to form the Milky Way.

What else can we learn about the Milky Way with just our own unaided eyes? When we observe it under dark country sky we can notice an astonishing amount of detail. Starting in the Summer Triangle, running southward through Sagittarius, is a dark lane, known as the Great Rift, seeming to divide the Milky Way. Some native people have pictured such features as dark constellations. Others thought them to be holes. Now we know they are the effect of dust which obscures the light of stars beyond. Such dust lanes are common along the spiral arms in the outer parts of galaxies like the Milky Way. It is in these spiral arms that stars continue to form.

As we scan the visible Milky Way we can also see that it is wider toward Sagittarius. This is the first clue that the center of the Galaxy is located in that direction. Other clues have confirmed this and we have learned that we are about 30,000 light years from the center. With optical instruments we cannot see very far toward the center because of the many stars and clouds of interstellar matter blocking our view, but with radio telescopes and infrared detectors we can know something about the central region. Apparently it is a very active place with gasses expanding outward and

Cover: The Milky Way

Unfold the cover to view the entire Milky Way. This painting, which is based on photographs of the Milky Way was done by Martin and Tatjana Keskula of the Lund Observatory in Lund, Sweden.

massive globular clusters of very old stars. The nucleus may contain a mass equal to millions of suns packed into a region smaller than a sphere which would encompass the orbit of Jupiter. Inside that, at the very core, there could be a black hole.

All of the stars and matter between the stars in the Milky Way are in motion. The Sun and its entire fleet of planets orbit the galactic center once every 200 million years, with a velocity of 230 kilometers per second. The Sun is just one of hundreds of billions of stars in the Galaxy. Current research is shedding new light on such things as the size and mass of the Galaxy. The primary part of the Galaxy is surrounded by a corona of smaller galaxies so close that they can be thought of as part of the Milky Way Galaxy. Included in this group are the famous Magallanic Clouds which can be seen from southern latitudes. The entire Galaxy, complete with this corona of satellite objects, may be as large as 400,000 light years in diameter and could contain as much matter as two trillion suns.

The cover of this issue of *Air & Space* shows a painting of the entire Milky

Way. A coordinate grid is superimposed with the equator through the center of the Milky Way. Lines of galactic latitude run parallel to the equator, increasing from zero at the galactic equator to 90 degrees at the galactic poles, at the top and bottom. Lines of galactic longitude run from pole to pole across the page from center to left and right. Cassiopeia is toward the left. Below the Milky Way, at about -20 degrees galactic latitude, is a small streak, the Andromeda Galaxy, located a million light years away from us. The Great Rift is the dark division running through the Milky Way from the left to the center where the cover folds. Sagittarius is about at the fold line. To the lower right, at -35 and -45 degrees galactic latitude, are two conspicuous blobs, the Magallanic Clouds. Sirius, the brightest nighttime star is at the right just below the central plane of the Milky Way, at about -8 degrees latitude.

Today, using satellite observatories, we study the contents of the Milky Way Galaxy and other galaxies in energy our eyes cannot see; X-rays, Ultraviolet, Infrared and Radio energy. But our knowledge of the Galaxy started with

what people can see under a country sky, looking at the silver river of light dividing the heavens. How long has it been since you have seen it? Why not on a clear, moonless summer night look at it more carefully than you have before—to enjoy its beauty and realize how much we have learned about it because people have been curious and have taken time to study it. ■

Readings

Bok, Bart J., "The Milky Way Galaxy," *Scientific American*, March 1981, pages 92-119.

Bok, Bart J. and Priscilla F., *The Milky Way*, Harvard University Press, 1974.

Aerospace Education Convention

The National Aviation/Space Education Convention will be held this year in Seattle, WA, during National Space week, July 13-20. The actual dates of the convention are July 13-17. For further information contact: American Society for Aerospace Education, 1750 Pennsylvania Ave. N.W., Washington DC 20006

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New Books from NASM

Space Science Comes of Age: Perspectives in the History of the Space Sciences edited by Paul A. Hanle and Von Del Chamberlain.

Scientific discoveries in space during the past three decades and the technology that made them possible are the subject of this new book published by NASM.

This handsome volume surveys the developments in space-science research, from the era before the launching of the first satellites to man's exploration of the Moon and beyond.

Edited by NASM's Paul A. Hanle and Von Del Chamberlain, this collection of scholarly papers by leading space sci-

tists and historians is divided into two segments—"Astronomy and Geophysics in Space" and "Toward a History."

In Part I, pioneers of the space sciences, such as Robert Jastrow, James Van Allen, Lyman Spitzer, Jr., and Eugene Shoemaker, recount major scientific discoveries. Part II presents historical works on the space sciences, with papers by historians Stephen Brush, C. Stewart Gillmor, and others.

The 210-page text is illustrated with more than 90 photographs, graphs and diagrams, depicting spacecraft, instruments and the images and information they transmitted to Earth.

Both the professional and general audience will find this an invaluable reference about a subject certain to be of great importance to humanity in the years ahead.

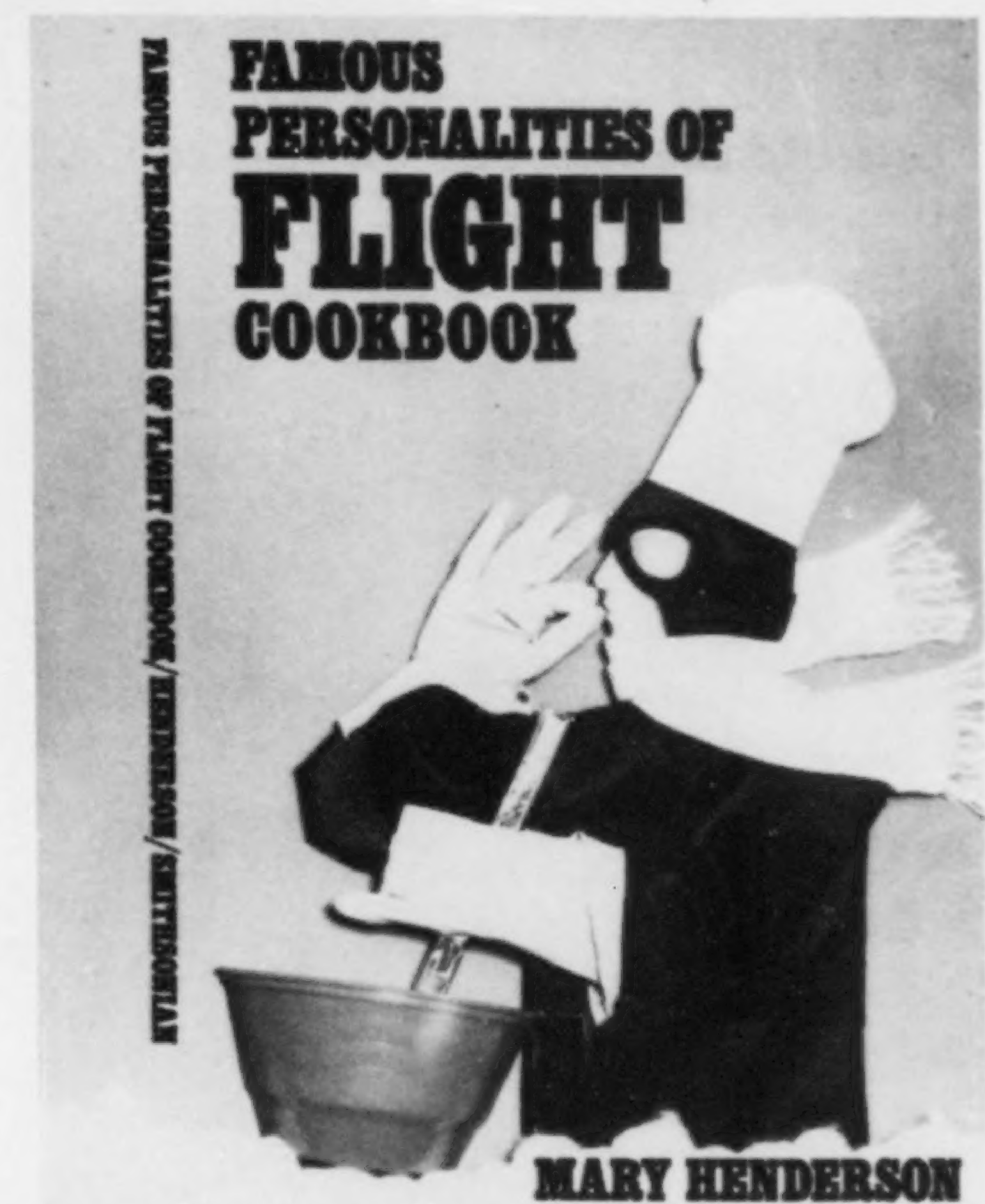
The 11 scientists and historians represented in the book participated March 23-24 at the National Air and Space Museum in a symposium, "Space Science Comes of Age."

Cloth, \$22.50; 210 pages; 8 x 10 inches. Paper, \$12.50.

Famous Personalities of Flight Cookbook by Mary Henderson

NASM's Mary Henderson has combined her hobby of cooking with her career in aerospace history to produce an unusual cookbook which should be a delight for aviation enthusiasts.

The book presents the favorite recipes of important persons in air and space history. For instance, Amelia Earhart's sour cream waffles; a pear salad that was one of Orville Wright's favorite dishes; a

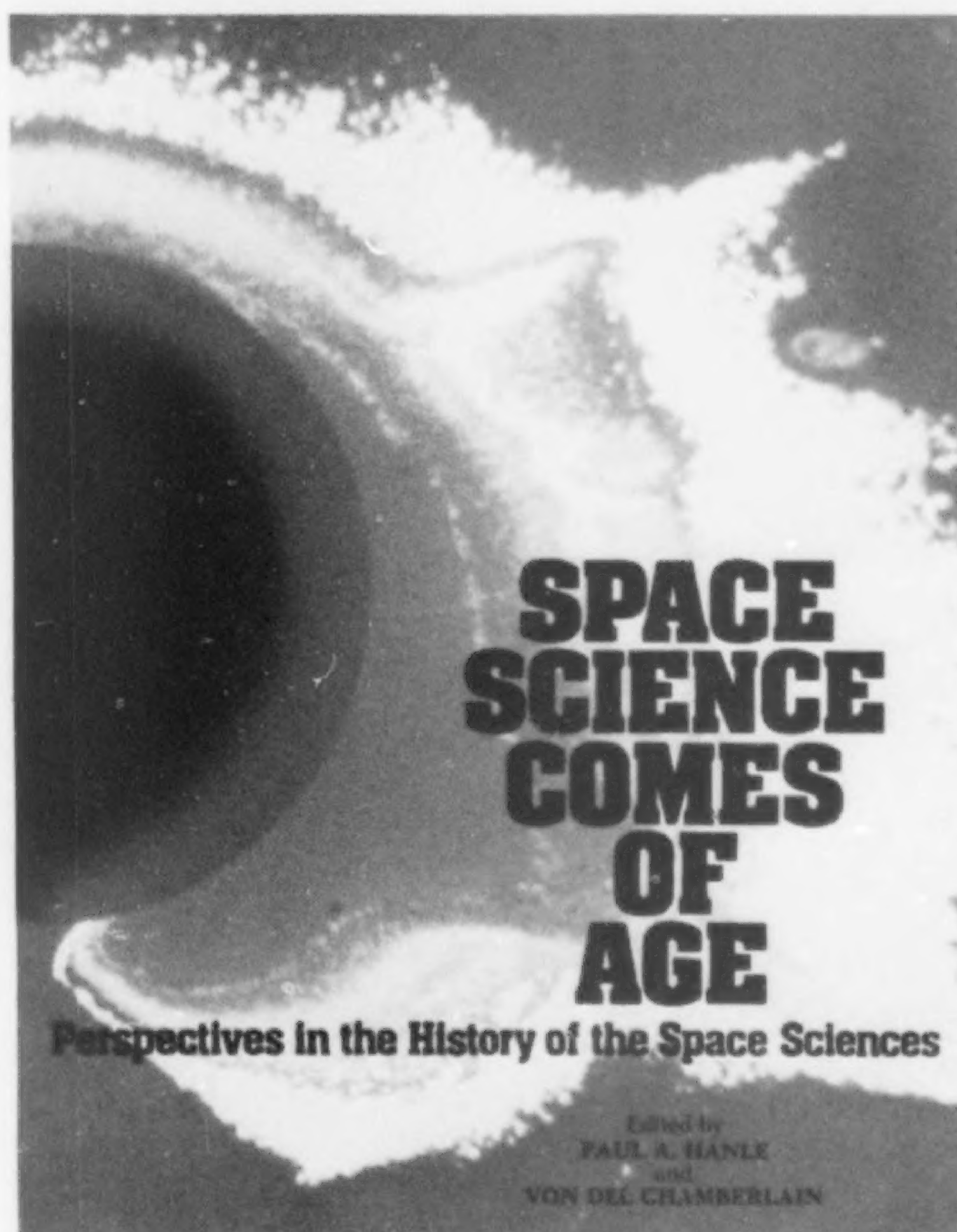


ham loaf recipe from John Glenn; and a very special chile from Harrison Schmitt, the lunar model pilot for Apollo 17.

There is also biographical material about the contributors, plus photos and anecdotes. A happy mix of aviation history and culinary delight.

Paper, \$4.95; 136 pages; 6 x 9 inches.

To order these books, and to obtain free information about the National Air and Space Museum's other hardbound and paperback books and posters on aviation and space subjects, write to Program Coordinator, Dept. AS-481, Room P-701, National Air and Space Museum, Smithsonian Institution, Washington, D.C. 20560. When ordering, include handling and shipping charges of \$1.75.



Index Volume 4, 1980-1981

Back issues of *Air & Space* are not available but articles may be ordered from University Microfilms International, 300 N. Zeeb Rd., Ann Arbor, Michigan 48106.

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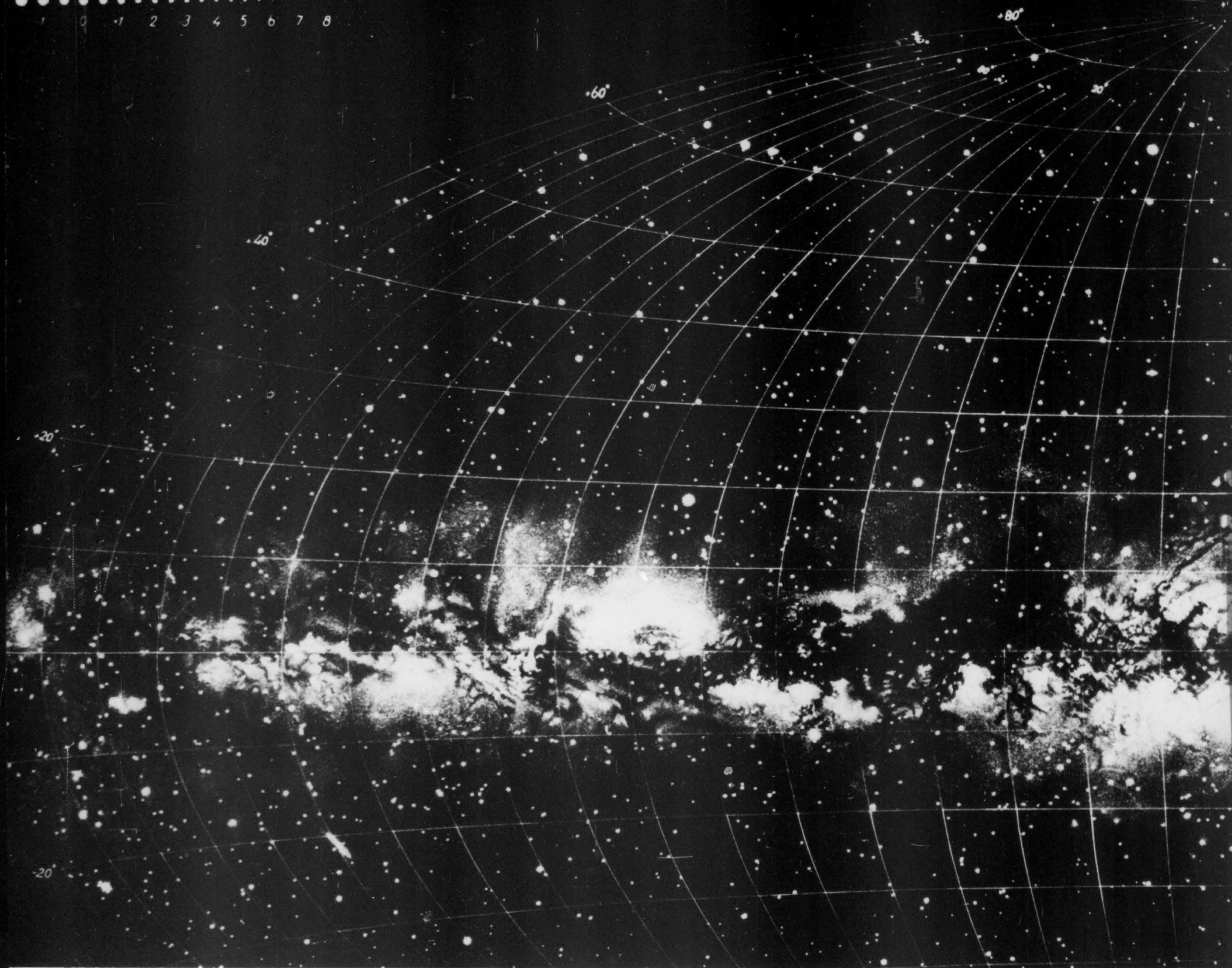
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